November 1984

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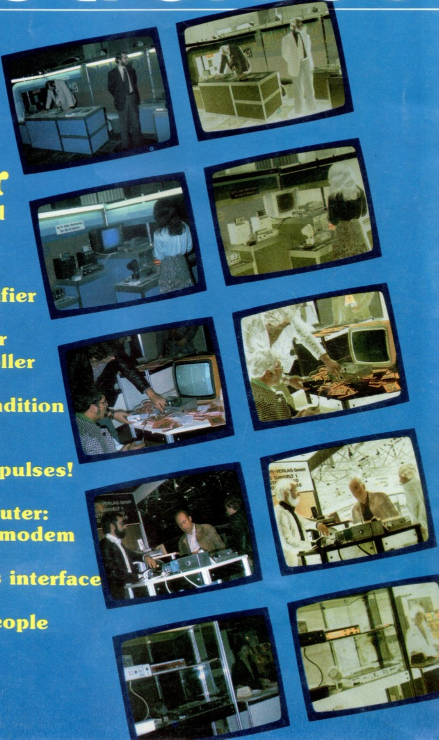
electronics



video colour inverter

with tricks in hand

dynamic pre-amplifier

a program for your 6845 video controller

simple battery condition meter

clean those ZX81 pulses!

dial another computer: data exchange by modem

RS232/Centronics interface

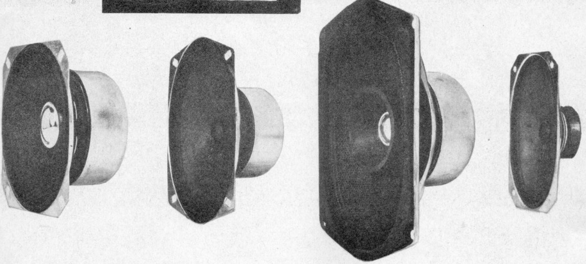
news • views • people

contents

This month's front cover depicts some samples of the effects that can be obtained with our video colour inverter featured on page 11.22 With this unit it becomes possible to invert either the contrast (black-and-white) or the composite colour signal (including the B/W information). An interesting project for video film makers and amateur photographers.

Starting with this issue, we will regularly publish projects for which components are normally available all over India.

NOW LUXCO INTRODUCE



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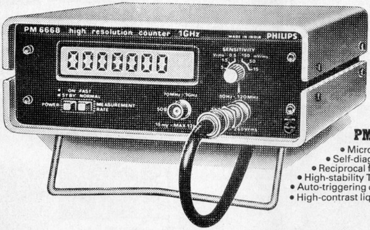
The smart counter



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Other big benefits that the micro-computer design brings are easy operation and minimal controls, since the built-in intelligence gives automatic triggering and range switching. Other features include further improvement in accuracy via the optional high stability TCXO. The 1 GHz PM 6668 does it all and more.

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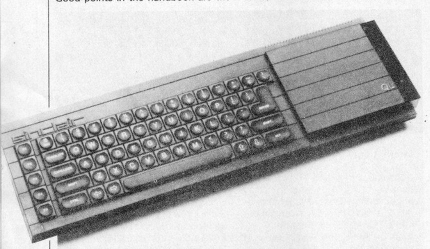
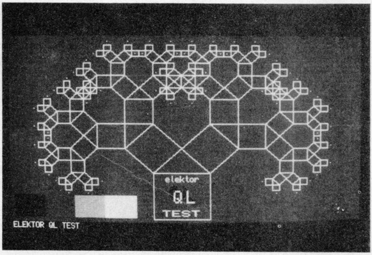
OBM/9262 RI

the QL: first impressions

We have spent the past few months getting ourselves acquainted with the three QLs we finally received in late June. Our first impression is that Sinclair has once again succeeded in setting new standards in up-to-date engineering and performance at a highly competitve price.
The hardware produced by Thorn is faultless: a traditional (by Sinclair's standards: good) keyboard that lacks a certain amount of 'feel', two microdrives that function well, and an uncluttered printed circuit. The picture quality is excellent: our television receiver (fitted with a SCART connector) constantly gave a sharp picture without any streaking or shifting and with good saturation of the colours. These features were certainly not so noticeable in the ZX and Spectrum equipment.
The super-BASIC, together with the Q-DOS operating system, is stored in a 48 K ROM (EPROM!). Super-BASIC is a new variant of BASIC in which aspects of Pascal and Algol have been incorporated. It makes programming a pleasure and avoids, for instance, those eternal declarations that are needed in Pascal.
As may be expected, there are also aspects that fall below standard. The handbook, for instance, appears to have been printed before it had been edited and without typeset corrections. We also found that the connection diagrams of the RS232 socket and the video socket were incorrect. Sadly lacking is a contents list, not to mention an index: the consequent constant leafing through the voluminous ring binder is certainly not our idea of tun!
Good points in the handbook are the clear warnings and cautions which can save a lot of frustrations. There is, for instance, the advice to format new microdrive cartridges more than once. Our first format request was met by the reply that the cassette cannot be formatted. The second attempt was, however, successful and we have never looked back since. We assume that the head of one of the drives had become somewhat dusty during the long delivery time...
Although the reading of our own files gave no cause for complaint, it would appear that the software delivered with the QL has been copied a little hastily. In one case we found it impossible to load the archive program supplied, and in another the text compiler cassette displayed a stubborn fault. Fortunately not a problem for us with three QLs, because we can interchange parts, but otherwise...
One of the three models suffered initially from picture distortion: vertical stripes, accompanied whenever the microdrive was started by horizontal ones. This fault was traced to low supply voltage and has since been corrected.
The power supply is a gem: contained separate from the QL in a black, plastic cube, it hardly gets warm and generates not a trace of hum. The 5 V voltage regulator in the QL itself is fitted onto a 'judicious' heat sink and gives the appearance of thermal excellence and reliability.
Each QL comes complete with four programs: 'quill', a text compiler; 'abacus' for arithmetical computations; 'easel' which enables the graphical representation of arithmetical work; and 'archive', a database. As far as operation is concerned, we have no complaint: instructions are always clearly indicated and invariably followed by further actions required. What we do not like is the speed at which various operations take place. Writing text gives no real problems, but during corrections the cursor moves exasperatingly slowly. It appears that after only half a page the text is written onto the microdrive, and since that means that the data have to be recovered first, reading back takes a lot of time. On the other hand, this is not unique to the QL: other well-known text compilers such as Wordstar suffer (but not so badly) from this inadequacy. However, when the cursor inertia is combined with the relatively slow microdrives, the times are only just acceptable in BASIC. It would seem that at least part of the programs will have to be rewritten soon!
The software was produced by PSION, the London software company, probably in a higher language and then translated to the 68000 code, which would explain the slow tempo.
It appears that in spite of the 128 K RAM there is not all that much room left for text, so that storing in the microdrive is necessary almost immediately. There is no indication of this in the handbook, but our tests indicate that there is at most 40 K available for text. We can only hope that we have made a mistake, because after allowing for the 32 K for the video display, there are 96 K left: according to our findings this means that almost half of the remaining capacity is used for the internal management of BASIC and Q-DOS and that sounds unbelievable! But even the designers had reckoned on only 32 K ROM and consequently provided only two IC sockets. One of the three EPROMs fitted is therefore simply soldered piggy-back onto another!
In the light of our experiences, we find the level and volume of criticism levelled at the QL from virtually all sides grossly exaggerated. We accept that some of it is warranted by the delays and other factors reported in an earlier issue of Elektor, but criticisms such as "Why another new computer?", and "Surely there is no market for this" just do not hold. Or do we detect an underlying tone in the vein of "At that price it cannot possibly be as good as claimed"?





What is the difference between the QL and, say, a MacIntosh, which, by the way, is about four times as expensive as the QL. Is it that the Mac has a 'real' drive? Or a built-in monitor? Or is it the 16-bit wide 68000 microprocessor which makes the Mac slightly faster? In other aspect the two are quite similar: both have 128 K RAM and excellent graphic, the Mac only in black-and-white but with a superior resolution. Yet, nobody says about the Mac: "And what are we going to do with that?". And we have not heard too many complaints in respect of the Mac's RS232 printer output which is suddenlly called 'non standard' in the QL. Moreover, nobody is in the least bit surprised that Apple have implemented their own operating system. One theory is that the Mac (mainly because of its price?) is geared towards the professional market, while the QL (mainly because of its price?) is intended for the hobby market and it is supposed to be here that there is no need for another machine. (It is true, of course, that the QL is based on a slightly simpler construction.) This would, indeed, be a remarkable philosophy, because what can there possibly be against an excellent piece of equipment that is available at a highly competitive price and is, moreover, so easy to operate? It is, of course, true that the software is not perfect, but when the redoubtable IBM-PC was launched, it offered little more than a text compiler. But, to remain with the Mac: its associated text compiler cannot handle more than 10 pages (!). And is it really so convenient to have to take your hand off the keyboard every time the cursor has to be positioned?

But enough of all this — we have no intension of criticizing any particular machine, only to draw fair comparisons. Nowadays, all systems tend to be so complex that teething troubles are unavoidable, and, as always, it's only a question of time for these to be solved. It is therefore even more surprising that there have been so many over-the-top reactions and demands that this new machine be perfect from day one. ◾

dynamic RAM power supply

It is often a common wish to extend the memory range of a microprocessor system with the aid of economically priced dynamic RAMs. On consideration, the first point to arise is the different supply voltages required by this type of memory device. Generally speaking, dynamic RAMs require supply voltages of +5 V, +12 V and −5 V. Unfortunately, it is not very often that all three supply rails can be found inside the computer concerned. Most microprocessor systems operate on a single 5 volt supply. How, therefore, can the missing supply voltages be obtained easily?

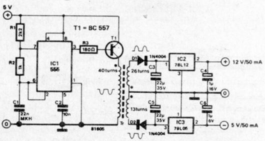
The most obvious solution, of course, is to replace the existing mains transformer by one which has three secondary windings and then add the required extra rectifiers and voltage regulators etc. However, this could prove to be rather expensive. A much cheaper solution is suggested by the circuit shown in figure 1.

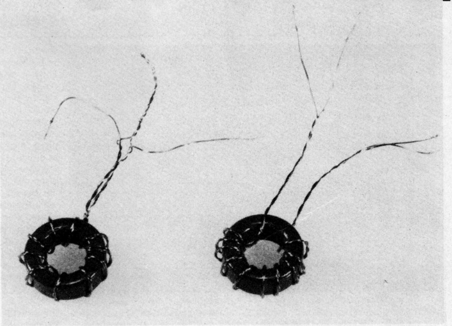
The principle used is the so-called 'chopper' The heart of the design is the well known 555 timer IC. It is used here as an astable multivibrator with an output frequency, at pin 3, of approximately 15.5 kHz. The actual frequency can be altered if required and can be calculated from the formula:

$$f = \frac{1.44}{(R1 + 2R2)\,C1}$$

The squarewave output at pin 3 of the 555 timer drives transistor T1, which in turn controls the current passing through the primary of the transformer. Different output voltages can now be obtained from the secondary windings. Obviously, these signals will still approximate a squarewave and will therefore require rectification, regulation and smoothing in the normal manner. This is accomplished by D1, C3, C4 and IC2 for the +12 volt supply and by D2, C5, C6 and IC3 for the −5 volt supply. Capacitors C4 and C6 should be tantalum types. The transformer can be constructed using a Siemens pot-core type B 65561 - A 250 - A 028 This has an A_L value of 250 nH and an air gap of 0.17 mm.

1





A balancing transformer (often called a balun, which is a contraction of *bal*anced/*un*balanced) is any device used to couple a balanced impedance, for instance an aerial, to an unbalanced transmission line, such as a coaxial aerial feeder cable.

balancing transformers

aerial matching made simple

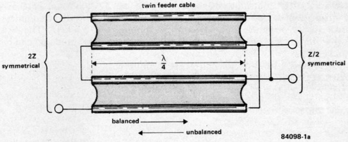
An example of a balancing transformer is given in figure 1: in 1a it consists of two pieces of twin feeder cable, while in 1b coaxial cable is used. In either case, the pieces of cable are a quarter wavelength long and are connected in parallel at one end and in series at the other. The two most important properties of such a balun are impedance transformation and symmetry transformation.

Textbooks refer to these baluns as quarter-wave matching sections. In such sections, the parallel-connected ends present an impedance of Z/2, where Z is the characteristic impedance of the cable used in the transformer. This termination of the section is asymmetrical.

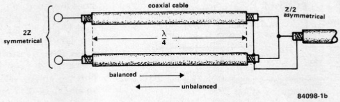
The series-connected ends present an impedance of 2Z, and the section here is open-circuited and symmetrical.

Figure 1. Illustrating the principle of a balancing transformer: (a) using balanced cable, and (b) using coaxial cable. Z is the characteristic impedance of the cable used.

1a



1b



Air-cored transformers

Dipole aerials for short-wave, UHF, and TV reception are normally connected to the radio or television receiver by a coaxial (75-Ω) cable. This causes the aerial to be loaded asymmetrically, even though its base impedance is equal to the characteristic impedance of the coaxial feeder cable. One effect of this is the flow of transient currents in the screen of the cable: the screen then acts as an aerial and this, of course, is not the intention! The simplest way of preventing the flow of these transient currents is connecting the aerial to the feeder cable via a transformer intended for matching 75-ohm impedances as shown in figure 2a. The transformer is wide-band, no changes are necessary to the coaxial cable, and there is nothing to adjust: it could not be easier. Unfortunately, this set-up has the disadvantage of no longer acting as a pure inductor at high frequencies.

Figure 2b illustrates a matching transformer for connecting a 300-ohm aerial to a 75-ohm feeder cable. The transformer is wound from lengths of coaxial cable with a characteristic impedance, Z_o, of 150 ohms. The relation between Z_o, the aerial base impedance, Z_a, and the characteristic impedance of the feeder cable, Z_f, is given by $Z_o = \sqrt{Z_a Z_f}$.

The length of the pieces of coaxial cable from which the transformer is wound should be not less than one tenth of the maximum wavelength and at least four times the inner diameter of the transformer. For an operating frequency of 100 MHz, therefore, the length should be not less than 30 cm, while the inner diameter of the transformer should not exceed 7.5 cm. The turns should be close spaced and the connecting points should be protected against moisture ingress by a plastic spray.

Toroidal transformers

Winding the transformers on a ferrite toroid results in a small, space-saving balun. Figure 3a shows an arrangement electrically similar to that in figure 2a: two lengths of enamelled copper wire of 0.25 mm diameter (SWG 32...34) are twisted together and then laid in ten turns around the toroid. If a T50-2 core is used, the transformer may be used over a frequency range of 12...280 MHz.

The configuration in figure 3b is similar to that in 2b and here again a bifilar winding of twisted enamelled copper wire of SWG 32...34 is used. This transformer matches a 300-ohm aerial to a 75-ohm feeder cable, that is, the impedance transformation ratio is 1:4. The correct terminals may be determined with a continuity test and then connected as indicated. The advantage is that this arrangement does not need 150-ohm cable which is not easy to obtain. On the other hand, a toroidal transformer is slightly more expensive.

2a

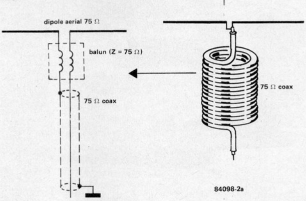
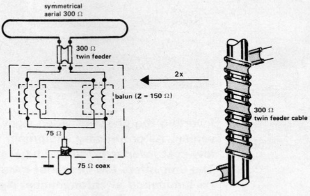
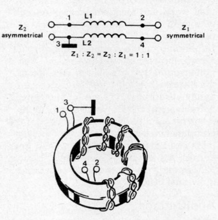


Figure 2. The simplest matching transformer: (a) the feeder cable near the aerial is wound into an air-cored inductor, and (b) constructed from 150-ohm twin cable.

2b



3a



3b

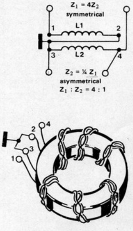
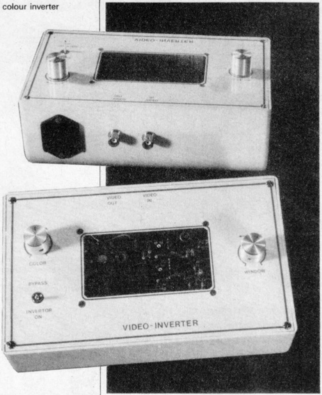


Figure 3. Similar arrangements as those in figure 2 but constructed from enamelled copper wire wound onto ferrite toroids.



video colour inverter

with a host of other interesting facets

Inverting the phase of video signals causes interesting effects on the screen. As proprietary equipment for this purpose is expensive, the low-cost inverter presented here may be of interest to many of you. The unit offers the choice of inverting the composite colour (= luminance + chrominance) signal, or the luminance (black and white information) signal only.

The inverter is of interest to three groups of people: video recorder owners who want to change the image on their television screens, video camera operators who want to incorporate trick images in their work, and amateur photographers who want to view their negatives as positives.
Depending on the setting of the relevant switch, the circuit provides normal, that is, non-inverted, images (which means that the inverter may be connected permanently), or inversion of the luminance and chrominance signals, or inversion of the luminance and adjustable inversion of the chrominance signal. The range of adjustment lies between full inversion and near-normal: the setting of the relevant control, P2, depends on the required effect and individual taste.

Applications

It should be noted that the inverter functions on the composite colour signal. Its input and output are therefore suitable for use only with equipment where this signal is readily available, for instance, via an A/V socket or BNC plug. This is, of course, no problem with modern video cameras, VCRs, and television receivers. Moreover, such a connection is easily fitted retrospectively to most older equipment. If you do not feel confident of carrying out this modification yourself, ask your local TV repair shop.
The use of the inverter as image modifier for video recordings is illustrated in figure 1. Your favourite piece of equipment may, for instance, be co-opted to function as part of a home discotheque. All you have to do is to record some suitable concerts and during playback to switch in the inverter at appropriate passages.
Figure 2a shows a suitable set-up for video camera operators. It is best to use a recorder with an electronic editing facility: the recorder is then stopped at the moment the switch-over from normal to inverted image, or vice versa, takes place, so that synchronization upsets are prevented.

If you are fortunate enough to possess two VCRs (for instance, a mains operated and a portable model), the set-up in figure 2b may be used. The advantage of this arrangement is that filming may be carried out as normal and the image modifications may be inserted during editing of the

1

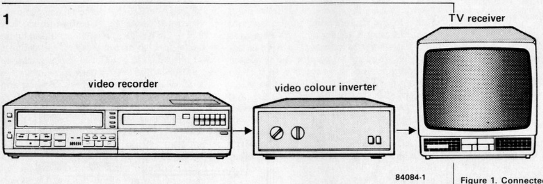


Figure 1. Connected between a video recorder and a television receiver, the inverter may be used for 'magic' effects on the screen.

2a

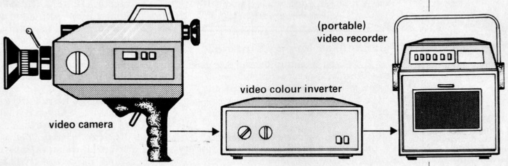


Figure 2a. Connected between a video camera and a VR, the inverter may be used to modify the information being recorded.

2b

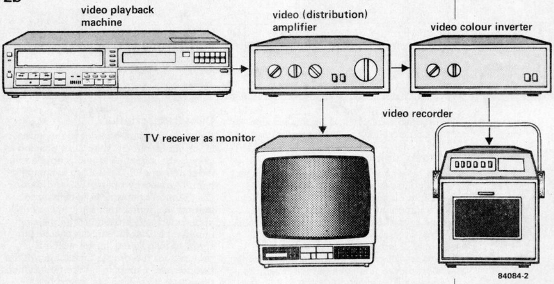


Figure 2b. This is perhaps the most interesting set-up, particularly for video camera operators: it will enable them to modify home-made film during the electronic editing.

recording. The video amplifier (for instance, the video distribution amplifier featured on page 1-30 of the January 1984 issue of Elektor) serves not only to compensate for losses in the recording and playback chain, but also to provide the possibility of using a TV receiver with A/V socket as monitor.

A suitable configuration for amateur photographers is shown in figure 3 which is self-evident, but has two important limitations. Firstly, the set-up is restricted to black-and-white negatives because it would be quite difficult to compensate for the orange mask on the negative, and, secondly, the video camera must be of

3

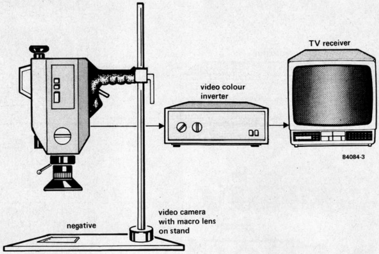


Figure 3. A further application enables black-and-white film negatives to be viewed positively on the screen.

4

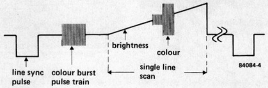


Figure 4. This illustrates the basic composition of a line scan. Luminance and chrominance are firmly interwoven. Note that this representation and that in figure 5 is purely schematic: viewed on an oscilloscope it would look quite different!

5

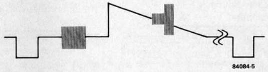


Figure 5. Same information as in figure 4 but with the single line scan inverted.

reasonable quality and be fitted with a good macro lens to ensure usable results.

Video signal

We have no intentions of embarking on a full course in video technology but will restrict ourselves to those aspects which are important to the circuit. The single line scan shown in figure 4 illustrates normal traversal of the composite colour signal. If we want to invert this signal without affecting the other functions of the TV receiver, it is necessary to invert the line scans as shown in figure 5. Both the luminance and the chrominance signals are inverted, because the chrominance signal is 'interwoven' with the luminance signal. If the phase of the colour burst signal is also shifted by 180°, the colour information returns to normal while the luminance signal remains inverted. How this is achieved will be explained in the circuit description.

Circuit description

Switch S1 in figure 6 switches the inverter in, or out of, circuit. With S1 in position as shown, the incoming signal is applied via input network C1-C2-R1-R2 to a clamping circuit formed by opamp IC2 and diode D3. The input network is necessary to transfer the signal from the camera or VR undistorted and present it with the right impedance. Unfortunately, it causes the signal to lose its d.c. off-set which is required for the proper functioning of the inverter. The clamping circuit reintroduces the off-set by pulling the lowest (most negative) component of the line scan to 0 V.

Because the clamping circuit has a high-impedance output, it is followed by buffer (voltage follower), IC1. The output of IC1 is available at pins 2 and 6 and is divided into two.

One part of the output is applied to comparator IC3 which regenerates the line

sync(hronizing) pulse (available at pin 7). The leading edge of this pulse triggers monostable multivibrator IC4. This monostable controls the actual run-off via electronic switches ES1...ES3. Switch ES4 is controlled direct by the output of the comparator, which we will return to later in this article.
The other part of the output of IC1 is applied across colour saturation control P1. The Q output of IC4 is at logic 1, which keeps switch ES2 closed, until the end of the colour burst pulse train. With colour inversion switch S2 in position 1, the signal from P1 is then applied to the non-inverting input (pin 1) of opamp IC6 via ES2; the phase of this signal is therefore not (yet) inverted. When the monostable changes state, output Q goes low and output $\overline{Q}$ becomes logic 1. Switches ES1 and ES3 are then 'on' and ES2 is open. The signal from P1 is applied to the inverting input (pin 14) of IC6 via ES1, so that the phase of the composite colour signal at pin 7 of IC6 is shifted by 180°. At the same time, ES3 applies a reference voltage from voltage divider P3/R9 to the non-inverting input of IC6, ensuring a correct and positive signal level at the output.
When S2 is set to position 2 and P2 is turned fully open (wiper at M), the colour burst signal is phase-shifted 180° by the action of T1. The colour information at pin 7 of IC6 is then shifted a total of 360° and is in phase again with the incoming signal.

It is evident that both inverted and non-inverted colour burst signals are present across P2 and this makes it possible for the degree of inversion of the colour information to be adjusted as required. In other words: colour may be continuously changed from normal to fully complementary; with P2 at the centre of its travel, there is no colour.
The line sync signal must, of course, be fed to the following circuit (TV receiver or video recorder) non-inverted and this is ensured by T2 and ES4. The switch is controlled direct by the output of comparator IC3.
Transistor T3 and resistors R16, R17 ensure a correct output impedance of 75 Ω.
The power supply is a conventional, voltage regulated ±5 V circuit. As the negative line is not loaded as heavily as the positive, the value of C13 may be rather smaller than that of C12.

Construction and calibration

If the printed circuit of figure 7 is used, there should be no special problems in the construction. The compact design enables the unit to be installed in a neat case. Amateur photographers should use presets in the P1...P3 positions, and this arrangement is also advisable for disco applications (so that not everybody can play around with the inversion settings). Others should find it advantageous to use normal potentiometers and fit these onto the case; connections between them and

6

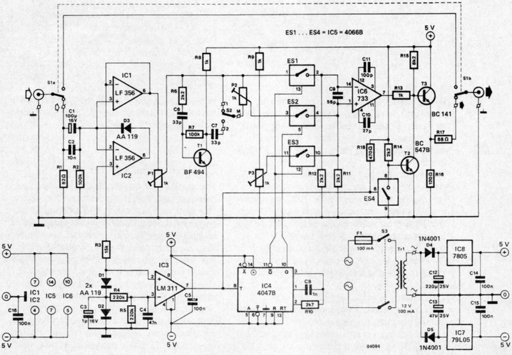


Figure 6. The circuit diagram of the inverter: possible extensions are explained in the text.

7

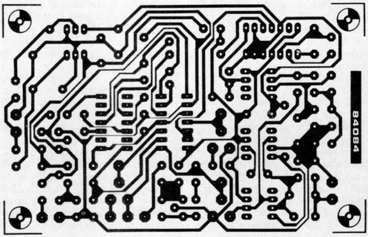


Figure 7. Component layout and track side of the printer circuit board: its use makes construction of the inverter a fairly simple matter.

Parts list

Resistors:
R1 = 82 Ω
R2, R7 = 100 k
R3 = 15 k
R4,R5 = 220 k
R6,R11,R12,R14 = 2k2
R8,R9,R13 = 1 k
R10 = 2k7
R15 = 8k2
R16 = 120 Ω*
R17 = 68 Ω*
R18 = 470 Ω
P1,P2,P3 = 1 k preset or potentiometer*

Capacitors:
C1 = 100 µ/16 V
C2 = 10 n
C3 = 1 µ/16 V
C4 = 47 n
C5,C14,C15,C16 = 100 n
C6,C7 = 33 p
C8 = 1 n
C9 = 56 p
C10 = 27 p
C11 = 100 p
C12 = 220 µ/25 V
C13 = 47 µ/25 V

Semiconductors:
D1,D2,D3 = AA 119
D4,D5 = 1N4001
T1 = BF 494
T2 = BC 547B
T3 = BC 141
IC1,IC2 = LF 356
IC3 = LM 311
IC4 = 4047B
IC5 = 4066B
IC6 = µA733
IC7 = 79L05
IC8 = 7805

Miscellaneous:
S1 = double-pole change-over switch
S2 = single-pole change-over switch
S3 = DPST mains switch
Tr1 = mains transformer 12 V/100 mA secondary
F1 = fuse, 100 mA, complete with carrier
printed circuit board 84084
case
two BNC or A/V sockets*

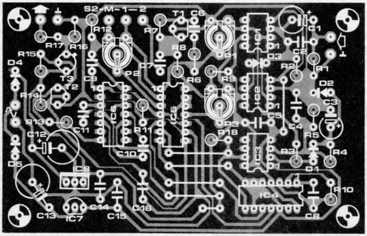
Optional:
R16 = 82 Ω
R17' = 68 Ω
P4 = 1 k . . . 100 k potentiometer, linear*

*see text

the printed circuit should be made in screened wire with the screen connected to earth. Where potentiometers are used, it is convenient to provide a graduated scale around, or a skirt under, the control knob.
The type of input and output connector depends really on the equipment the inverter is to be used with. BNC connectors are very convenient and easily fitted but lose their advantages if adapter cables become necessary. If you use A/V sockets, interconnect all pins, except 2 (= composite colour signal), and connect pin 3 to the nearest earth point in the circuit.
Calibration is relatively simple and requires a video signal source and a test card (this may, for instance, be one recorded from a broadcasting station). Set switch S1 to position 'inverter on' and S2 to position 1. Controls P1 and P3 should then be adjusted to give rich colours and a good contrast respectively. Finally, set S2 to position 2 and check that colours can be continuously changed from normal to complementary by P2.

Other interesting facets

For another of our experiments we needed one half of the screen image inverted and the other half normal. This requires a lenghtening of the time IC4 is triggered and this is achieved by connecting an additional preset in series with R10: the switch-over to inverting then takes place sometime during the line scan. If the trigger period is further extended, inversion does not take place until the *next* line scan. This gives the interesting picture of alternate normal and phase-inverted lines. Making the trigger period longer still (a 100 k preset in series with R10) causes the effect to be visible over one part of the screen image only. The additional preset is connected as shown



S1 = inverter in/out
S2 = colour inversion in/out
S3 = mains on/off

P1 = colour saturation
P2 = colour inversion adjustment
P3 = contrast
P4 = trigger period control (see text)

in figure 8.
As the inverter is relatively inexpensive, particularly when compared with commercially available models, it is quite feasible to connect two or more of them in cascade. We think that four or five of them so connected will function without any problems, although we have not built so many prototypes ourselves and cannot therefore prove it. Such a set-up offers so many possibilities for achieving trick effects that it is impossible to envisage them all: we'll give you two.
When two inverters are connected in series of which only one inverts the colour, the resulting picture is normal as far as black-and-white information is concerned, but the colour is inverted.
The second example is illustrated in figure 9. Here, the onset of the first inverter is arranged so that one part of the picture remains normal; the second part, in the centre, has the black-and-white information inverted. The second inverter inverts the inverted black-and-white information and inverts the colour. The overall picture will then show: normal — black-and-white inverted — colour inverted. This all presupposes that both inverters are fitted with the additional preset P4.
For really accurate settings, you could use multi-turn presets or potentiometers, but this is really a matter of cost. In our experience, the inverter can be calibrated very well with just fingertip control.
A final tip: if you want to monitor the modified image being recorded, reduce R16 to 82 Ω, connect a 68 Ω resistor, R17', in parallel with R17 as shown in figure 10, and add a socket as appropriate.

8

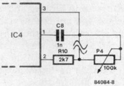


Figure 8. This shows how an additional preset may be connected in series with R10 to extend the trigger period of IC4. The facets which become possible by this simple means are explained in the text.

9

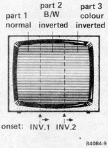


Figure 9. When two inverters are connected in cascade, and both are fitted with the additional preset shown in figure 8, this sort of trick becomes possible.

10

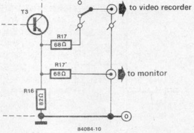


Figure 10. A small modification as illustrated makes it possible to monitor what is being recorded.

Computers do not always have to perform difficult tasks to be useful. Very often it is the boring, repetitive, soul-destroying type of work we make them carry out. Calculating the hexadecimal values of the registers in the 6845 (or 6545) cathode ray tube controller (CRTC) for any given screen format could hardly be called mind-taxing but it is the sort of job that any computer, using this BASIC program, will perform correctly and as often as you like.

programming the 6845

a BASIC description of the CRTC registers

P. Fransen

The value of changing the screen format on your Elektor VDU card (or any other VDU card that uses a 6845 or 6545 CRTC) may not be immediately obvious but once hooked on the technique it is something you are likely to do more and more often. Furthermore this program is interesting and instructive in its own right.

The parameters

The 6845, and all the various details about structure, organisation of the screen format and the signals used, have already been dealt with in Elektor and in other books so we will not bother about that here. Any information required can be found in the literature listed at the end of this article.

The video norms currently in force in Europe use a line frequency of 15625 Hz and an frame frequency of 50 Hz. The time needed to sweep one line on the screen is

1/15625 s = 64 μs, and the time to sweep a complete frame is

1/50 s = 20 ms.

We must now calculate the clock frequency required by the system.

Line synchronisation

Each character is based on a horizontal width of eight screen dots, each of which is scanned in one clock period. Knowing the number of horizontal characters now enables the clock frequency (which we will call f_x) to be calculated. The dot frequency is $1/f_x$ and the character frequency is eight times this value. With a total of 128 horizontal characters the clock frequency is:

$$\frac{128 \times 8}{64} = 16 \text{ MHz.}$$

1

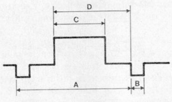


Figure 1. This diagram indicates the relationship between the signals generated by the CRTC and the parameters defined by the user. If period A is the line sync pulse duration, B is the width of that pulse, C is the width of the horizontal display and D defines the horizontal position of the image window. If, on the other hand A, is the frame pulse period, B, C and D are the corresponding vertical parameters.

This is no coincidence, actually, as the figure of 128 characters is chosen because it allows the common, inexpensive 16 MHz crystal to be used.

Working out the character duration gives us:

$$\frac{8 \times 1}{16 \text{ MHz}} = 0.5 \ \mu s.$$

The total number of horizontal characters (minus one) between two horizontal sync pulses forms the contents of register R0. In this example we get:

128 − 1 = 127

or $7F_{HEX}$.

The contents of register R1 indicates the number of characters per line which in most cases will be 80, or 50_{HEX}.

The position of the horizontal sync pulse is determined by the contents of register R2 (see figure 1). This is calculated as follows:

HP = ((TSL − DT − 1.5 × LPB)/2) + DTZ

where DT = the width of the usable window (in μs)

TSL = the line time (in μs)

LPB = breadth of the line sync pulse (in μs), and

HP = the position of the line sync pulse (in μs).

The value of DT is:

80 × 0.5 = 40 μs.

The value of LPB (see R3) is

8 × 0.5 = 4 μs.

Inserting these values into the formula, we get

HP = ((64 − 40 − 1.5 × 4)/2) + 40 = 49 μs.

The factor 1.5 is an optional character to permit the position of the window on the screen to be accurately set.

Register R2 will contain

49/0.5 = 98

which is represented by 62_{HEX}.

Image synchronisation

In order to calculate the image synchronisation the number of screen lines per character must be known. The minimum number is eight, and this is generally used both for text and graphics characters. As the maximum number of character lines is 25, nine screen lines per character line are generally chosen. This gives 24 lines of characters on the screen. Each line then has a duration of

9 × TSL = 9 × 64 = 576 μs,

and sweeping the whole 24 lines takes
$24 \times 576 = 13{,}824\ \mu s$.
This time is generally indicated by VT.
The contents of register 6 will be 24, or 18_{HEX}.
The frame time must be as close as possible to 20 ms. With the line time calculated above we see that
$20{,}000/576 = 34.72$ lines.
Rounded off, this gives 34 lines (24 of which are usable) between successive frame sync pulses. From this we obtain the contents of R4: 34, or 21_{HEX}. As the frame time is only
$34 \times 576 = 19{,}584\ \mu s$
there are still
$20{,}000 - 19{,}584\ \mu s$
needed. A number of extra lines must be swept to bring the total screen time up to 20 ms. The actual number is calculated by dividing the remainder by the line time:
$416/64 = 6.5$
so this is rounded to 6, giving a value of 06_{HEX}.
Calculating the position of the frame sync pulse is similar to that for the line sync:
$VP = VTT - (VT + 1{,}500)/2\ VT$
where VTT is the frame time. In our example:
$34 \times 576 + 6 \times 64 = 19{,}968\ \mu s$.
The contents of R7 can be calculated from VP:
$(19{,}968 - (1500 + 24 \times 576))/2 + 24 \times 576 = 16{,}146\ \mu s$.

Table 1. Using this short BASIC program it is a very simple matter to calculate the appropriate hexadecimal addresses to insert into the 6845 registers for any given screen format.

Table 1.

```
100 REM *** CONSTANTS ***
105 DIM R(15)
110 R(3)=8
120 K$="REGISTER"
130 L$="MICROSECONDS"
150 REM ********** R0 **********
160 PRINT "HORIZONTAL LINE LENGTH (CHAR.): "
170 INPUT A0
180 R(0)=A0-1
190 TC=64/A0
200 FX=8/TC
210 PRINT "FREQUENCY = ";FX;" MHZ"
220 PRINT "CRYSTAL FREQUENCY (MHZ): "
230 INPUT FX
240 TC=1/(FX/8)
250 LPB=R(3)*TC
260 TSL=A0*TC
300 REM ********** R1 **********
310 PRINT "NUMBER OF CHARACTERS PER LINE: "
320 INPUT R(1)
330 DT=R(1)*TC
400 REM ********** R2 **********
410 HP=DT+(TSL-1.5*LPB-DT)/2
420 R(2)=HP/TC
500 REM ********** R3 **********
600 REM ********** R4 **********
610 PRINT "NUMBER OF SCAN LINES: "
620 INPUT A
623 IF A<8 THEN PRINT "MINIMUM 8 SCAN LINES !":GOTO 610
625 PRINT "NUMBER OF CHARACTER LINES: "
630 INPUT B
640 TR=(A)*TSL
650 VT=(B+1)*TR
660 IF VT<=20000 THEN 680
665 PRINT
670 PRINT " IMPOSSIBLE! "
675 PRINT "FEWER CHARACTER OR SCAN LINES. PLEASE. "
677 GOTO 600
680 Y=INT(20000/TR)
690 R(4)=Y-1
700 REM ********** R5 **********
710 R(5)=INT((20000-Y*TR)/TSL)
800 REM ********** R6 **********
810 R(6)=B
815 VD=R(6)*TR
900 REM ********** R7 **********
910 R(7)=INT((((TR*Y+TSL*R(5))-(1500+B*TR))/2+B*TR)/TR)
915 VP=R(7)*TR
1000 REM ********** R8 **********
1010 R(8)=0
1100 REM ********** R9 **********
1110 R(9)=A-1
1200 REM ********** R10 & R11 **********
1202 REM UNDERLINE CURSOR
1204 IF A=8 THEN R(11)=A :R(10)=64+A :GOTO 1300
1206 R(10)=73 :R(11)=9
1300 REM ********** R12, R13, R14 & R15 **********
1310 R(12)=0
1320 R(13)=0
1330 R(14)=0
1340 R(15)=0
1350 PRINT :PRINT
1352 PRINT "SCREEN FORMAT = ";R(1);" * ";B
1354 PRINT: PRINT
1700 FOR Q=0 TO 15
1710 PRINT K$;" R";Q;
1720 PRINT TAB(20);" = ";
1727 Z2=R(Q)
1730 GOSUB 2000
1740 PRINT
1750 NEXT Q
1760 PRINT :PRINT:
1800 PRINT " CLOCK PERIOD                  ";TC;L$
1810 PRINT " LINE SYNC. PULSE WIDTH        ";LPB;L$
1815 PRINT " LINE SYNC. PULSE PERIOD       ";TSL;L$
1830 PRINT " HORIZONTAL DISPLAY TIME       ";DT;L$
1840 PRINT " HORIZONTAL POSITION           ";HP;L$
1850 PRINT " CHARACTER LINE PERIOD         ";TR;L$
1855 VE=Y*TR+R(5)*TSL
1860 PRINT " RASTER SYNC. PERIOD           ";VE;L$
1865 PRINT " VERTICAL DISPLAY TIME         ";VD;L$
1867 PRINT " VERTICAL POSITION             ";VP;L$
1990 END
2000 REM ********** DEC TO HEX **********
2010 PRINT "$";
2020 FOR Z=1 TO 0 STEP -1
2030 Z1=INT(Z2/16^Z)
2040 Z2=Z2-Z1*16^Z
2050 Z1=Z1+48
2060 IF Z1>57 THEN Z1=Z1+7
2070 PRINT CHR$(Z1);
2080 NEXT Z:RETURN
```

This value is divided by the line time
16,146/576 = 28.03
giving 28 when rounded, or $1C_{HEX}$.
Register 8 will almost invariably contain zero as we do not want to have an interlaced frame. The contents of register 9 is simply the number of screen lines per character line.

Table 2.

```
RUN
HORIZONTAL LINE LENGTH (CHAR.):
? 128

FREQUENCY =  16  MHZ

CRYSTAL FREQUENCY (MHZ):
? 16

NUMBER OF CHARACTERS PER LINE:
? 80

NUMBER OF SCAN LINES:
? 9

NUMBER OF CHARACTER LINES:
? 24


SCREEN FORMAT =  80  X  24


REGISTER R 0        = $7F
REGISTER R 1        = $50
REGISTER R 2        = $62
REGISTER R 3        = $08
REGISTER R 4        = $21
REGISTER R 5        = $06
REGISTER R 6        = $18
REGISTER R 7        = $1C
REGISTER R 8        = $00
REGISTER R 9        = $08
REGISTER R 10       = $49
REGISTER R 11       = $09
REGISTER R 12       = $00
REGISTER R 13       = $00
REGISTER R 14       = $00
REGISTER R 15       = $00


CLOCK PERIOD                .5 MICROSECONDS

LINE SYNC. PULSE WIDTH      4 MICROSECONDS

LINE SYNC. PULSE PERIOD     64 MICROSECONDS

HORIZONTAL DISPLAY TIME     40 MICROSECONDS

HORIZONTAL POSITION         49 MICROSECONDS

CHARACTER LINE PERIOD       576 MICROSECONDS

RASTER SYNC. PERIOD         19968 MICROSECONDS

VERTICAL DISPLAY TIME       13824 MICROSECONDS

VERTICAL POSITION           16128 MICROSECONDS

OK
```

Table 2. When the four user-defined parameters have been loaded the contents of the CRTC registers are output in this way.

The cursor

The program dealt with in this article does not permit a very flexible programming of the cursor. This can be improved by including a few BASIC lines to add a choice of options as we will now see. Registers 10 and 11 define the upper and lower limits (the size, in other words) of the cursor respectively. Bits 5 and 6 of register 10 determine whether the cursor is present at all and if so whether it flashes or simply lights. As an example, assume we want a non-flashing cursor which has the form of a single underline. The register 10 configuration needed is given by the value 48_{HEX} (more details of this are given in Paperware 3). As the lower limit of the cursor will be the last line swept (for any given character line), register 11 must contain 08_{HEX}. Unlike what we have dealt with up to now, registers 12...17 do not lend themselves to individual calculations so we will have to be content simply to initialise them.

A few examples

Programming the 6845 is made easier in any system with the aid of the program shown in table 1. Given four parameters (the number of characters between two line sync pulses [horizontal total], which gives the ideal crystal frequency that should be used, the number of characters used per line, the number of screen lines per character line and the number of character lines on the screen) it returns the hexadecimal contents of all the 6845 registers concerned. An example of this result is shown in table 2. All the parameters can also be stated in decimal base.
Having let the program work out all these results the next question is what to do with them. If you are not using the Elektor VDU card and its software you will have to study your system's software to find out how to access the 6845 initialisation routine. In the Elektor system (detailed in Paperware 3) this initialisation procedure carries out two operations: one (routine MOVCRT) to change the look-up table containing the RAM and ROM parameters (CRT timing table) and the other to transfer the RAM parameters to the CRTC (routine CRTINT). This latter routine is the one we are interested in. Before starting it (by means of DISK!GO F36C, for example) the data calculated by the BASIC program of table 1 must be saved from address $EFDC_{HEX}$ (61404 decimal) onwards. As is often the case, changing the screen format demands a total erasure so execute the RESET routine ($F330_{HEX}$) immediately and this simply calls the CRTINT routine needed to program the CRTC.

References:
Elektor Paperware 3 and 4
Motorola 8-bit Micropressors Manual
Synertek Data Book

The ZX 81 is one of the most popular personal computers but it does leave a lot to be desired in certain respects, one of the most notable of which being its cassette interface. Any ZX 81 user who has had to type in a complete program again because it could no longer be loaded from cassette will confirm this. The pulse cleaner described here is designed to make such problems a thing of the past. This makes it a must not only for ZX 81 users but also for any other computer that uses a similar type of pulse/pause system for the cassette connection.

ZX81 cassette pulse cleaner

a cassette output signal cleaner for computers with single-frequency FSK

The Sinclair ZX 81's cassette interface uses frequency shift keying (FSK) with a single frequency. The signal is built up of a number of pulses, a pause, a number of pulses again, another pause, and so on (see figure 1a). The number of pulses between two pauses indicates the logic level: four pulses represent a logic zero and eight pulses are used to indicate a logic one. If this signal is stored on a cassette tape the 'digital' shape cannot be properly processed due to limitations in the recorder's electronics and the qualities of the tape itself. When the data is read from the tape it will enter the computer as a signal that looks something like that shown in figure 1b. The oscillation on the last pulse before a pause could cause the computer to falsely consider this as an extra pulse, with dire consequences. In order for the computer to be able to process it properly this signal should really be made into a digital signal with all the interference removed.

The layout

The various parts of the circuit are seen in the block diagram of figure 2. The incoming signal from the cassette recorder is first passed through an adjustable attenuator before being amplified and passed through a band-pass filter. This is followed by another amplifier and a high-pass filter. All this is necessary to remove any low frequency oscillations from the signal as the computer could interpret them as extra pulses. The filtered signal is then fed through a negative and positive peak rectifier. A Schmitt trigger compares these output signals with the signal from the high-pass filter to ensure that short noise pulses are also removed. The result is a clean digital cassette signal at the output. The output signal from the positive peak rectifier, incidentally, is also used to control the attenuator at the input.

1

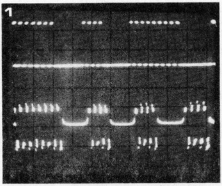


Figure 1. These are the sort of pulses that appear at the ZX 81's cassette output (top). After processing by the cassette recorder the signal (bottom) does not look quite so 'clean'.

2

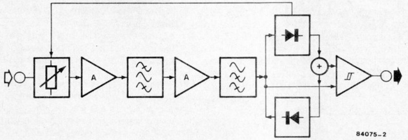


Figure 2. The circuit for the pulse cleaner, as the block diagram here shows, consists of some amplifiers and filters, a pair of peak rectifiers, a comparator section and an attenuator.

The circuit

The circuit diagram for the pulse cleaner is shown in figure 3. The input signal is first of all attenuated by preset P1 and then passes to the adjustable attenuator. The output of positive peak rectifier A2 determines the d.c. voltage at the base of transistor T1, which, in turn, decides the current passed through diodes D1 and D2 and therefore the impedance (or, strictly speaking, the differential resistance) of the diodes. When the output voltage of A2 is high the attenuation of the input signal will be correspondingly high. The moving coil meter in the collector line of T1 gives a visual indication of the strength of the signal.
The attenuator is followed by op-amp IC1 which amplifies the signal by a factor of eleven and then feeds it to the band-pass filter consisting of R4 . . . R9 and C3 . . . C8. The filtered signal is amplified by a factor of 100, by A1, to compensate for the attenuation introduced by the band-pass filter. The low frequency part of the signal is then removed by high-pass filter R12 . . . R14/C11 . . . C13 whose cut-off point is at about 9 kHz.
The treated signal is fed to the inputs of the two peak rectifiers, A2 and A3, and the non-inverting input of Schmitt trigger A4. Each rectifier consists of an op-amp with a diode at the output. A 22 n capacitor (C15 or C17) is charged to the maximum value of the input voltage via the diode, which is part of the op-amp's feedback loop. The 100 Ω resistors are needed to limit the charging current that the op-amps provide.
The output signals from the two rectifiers are added via resistors R19 and R21 and then go to the inverting input of A4. The other input of the Schmitt trigger, as we have already noted, is connected to the output of the high-pass filter so that A4 compares the rectifier signals with the differentiated cassette pulses provided by the filter. The output of the circuit is a clean rectangular waveform that can be fed directly to the ZX 81 cassette input.

3

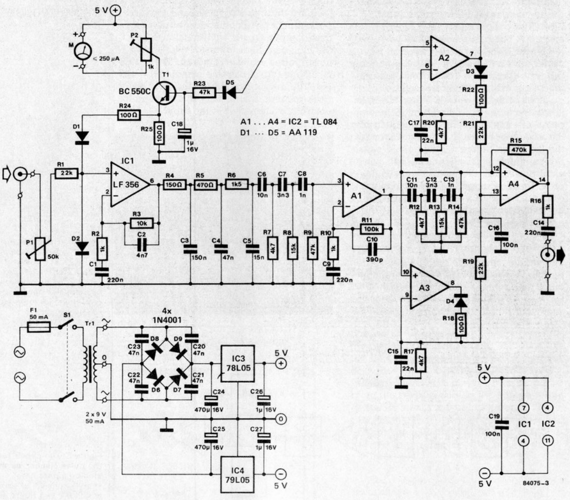
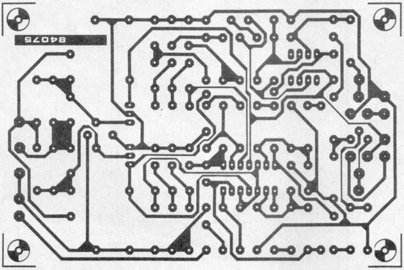
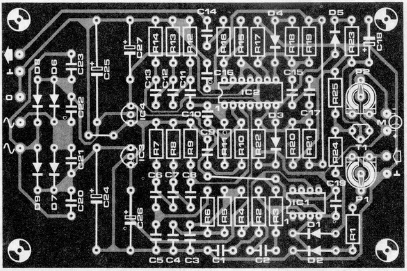


Figure 3. The circuit diagram for the pulse cleaner. As the circuit is quite straightforward all the sections from the block diagram can easily be found here.

4





Parts list

Resistors:

R1,R19,R21 = 22 k
R2,R10,R16 = 1 k
R3 = 10 k
R4 = 150 Ω
R5 = 470 Ω
R6 = 1k5
R7,R12,R17,20 = 4k7
R8,R13 = 15 k
R9,R14,R23 = 47 k
R11 = 100 k
R15 = 470 k
R18,R22,R24,R25 = 100 Ω
P1 = 50 k preset
P2 = 1 k preset

Capacitors:

C1,C9,C14 = 220 n
C2 = 4n7
C3 = 150 n
C4,C20 . . . C23 = 47 n
C5 = 15 n
C6,C11 = 10 n
C7,C12 = 3n3
C8,C13 = 1 n
C10 = 390 p
C15,C17 = 22 n
C16,C19 = 100 n
C18,C26,C27 = 1 μ/16 V
C24,C25 = 470 μ/16 V

Semiconductors:

D1 . . . D5 = AA 119
D6 . . . D9 = 1N4001
T1 = BC 550C
IC1 = LF 356
IC2 = TL 084
IC3 = 78L05
IC4 = 79L05

Miscellaneous:

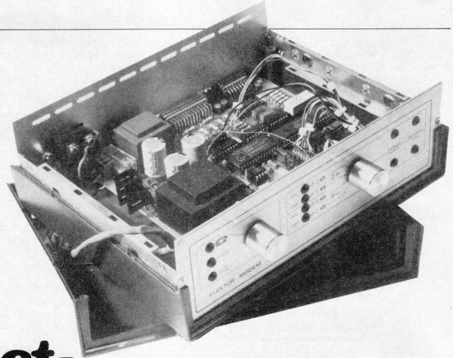
F1 = fuse, 50 mA slow blow
M1 = moving coil meter, ⩽250 μA f.s.d.
S1 = double pole mains switch
Tr1 = mains transformer, 2× 9 V, 50 mA

Figure 4. The printed circuit board for the FSK pulse cleaner can be fitted into its own case or there may be room for it within either the computer or the cassette recorder.

In practice

Small though this circuit is we thought it worthy of a printed circuit board design. This is shown in figure 4. As the power supply is included on the printed circuit board the only external components are the transformer and, of course, the meter. The various connection points, input, output, meter and power, are all clearly marked. When everything is connected and mounted the two presets must be set. Calibrating and testing the circuit is done with the pulse cleaner connected between ZX 81 and cassette recorder. Now, while trying to load some (well recorded) programs from the cassette, trim preset P1 until all programs are received correctly.

When this is done set P2 so that the needle of the meter is in mid scale while programs are being loaded.
The meter reading can be used as a reference point when loading programs. If the needle does not indicate mid scale P1 should be trimmed until the reference position is again indicated. In this way even programs that have been difficult to load in the past can now be loaded properly.



direct-coupled modem

A direct-coupled modem is the most reliable method of sending data via a telephone line that a computer user could hope for. It is not particularly easy to design a good and reliable direct-coupled modem but this is greatly simplified by using a dedicated modem IC. Using this IC, the AM7910, such a modem can be kept relatively small and inexpensive, as the design here shows. An important point about this modem is that it allows various different standards to be used, V21 and V23 being the ones that most concern us. The auto-answer facility enables the modem to receive messages without the computer user necessarily having to be present. The connection between modem and computer is made via an RS232 connector with V24 protocol and a modified connector for TTL levels.

a multi-standard alternative to the acoustically-coupled modem

A kit of the 'problem' parts for this modem will be available from Technomatic Ltd. Please contact them directly for details.

> **Type Approval**
>
> Quite understandably the Indian Telecom Research Centre will want to be sure that any equipment connected to the telephone network meets certain standard. For this reason modems and other telecommunication equipment will probably have to be submitted to the appropriate authority for approval. It is advisable to contact the Telecom Research Centre, New Delhi, for full details.

In preparation for this project we published an article in last month's issue ('data transmission by telephone') to deal with the theory behind the connection of a modem to the telephone network. That article also dealt briefly with the AM7910 modem IC that is used in this project. Knowing that this IC is a 'single-chip modem' it may be surprising how many external components are needed to make it tick. All this is required for the two interfaces present and to generate and process the various signals used. In addition to this the modem must be able to receive the data even in the presence of interference and it must not itself generate any interference. We have, of course, designed this modem to the very highest standards but it must be noted here that, like any equipment connected to the telephone line, it must have type approval

before it may be used.
The direct-coupled modem's superiority over its acoustically-coupled counterpart is easily stated: the chance of errors occurring during data transmission is much smaller. If you have ever had to spend hours debugging a program received via an acoustically-coupled modem it will soon seem that it might have been better to simply send a floppy disk in the post in the first case. As someone once said 'reliability is everything'.

Features

■ The modem can be switched to various different standards. The ones that most concern us are V21 and V23. As we noted in last month's article, V21 is the more common and has a 300 baud full-duplex operation. The V23 standard, on the other hand, is half-duplex with speeds of 1200 and 75 baud for the two channels. There are various other different standards possible with the AM7910 but, as we do not intend to use them, we will not deal with them here. Suffice it to say that they exist.
■ The auto answer facility means that the modem can accept data messages if there is nobody home. In order to do this the modem detects the bell signal and then it looks to see if there is actually another modem at the other end of the line. If not it simply 'hangs up'.
■ There are two input connectors: one RS232 with V24 protocol and a modified RS232 that operates with normal TTL levels. These two connectors make it possible to send and receive at a speed of 1200 baud. Signals for the 75 baud back channel are automatically converted to this low speed by the modem circuit and later reconverted. During this conversion the appropriate wait signals are, of course, sent to the computer.
■ The complete transmitter and receiver sections, including all the necessary filters, are contained in the AM7910. The great advantage of this is that the modem needs no calibration.

The actual circuit

The basics of the circuit are seen in the block diagram of figure 1. The heart of the circuit is the AM7910, which contains a complete modem (transmitter, receiver, interface logic and so on). This is surrounded by various extras that are needed for the RS232 and TTL ports, the 1200/75 baud converter, the switching logic to select the different modes, the automatic switch-off facility if the carrier is not detected for a certain length of time and the bell detector that is needed for the auto answer facility. As the block diagram is fairly self-explanatory we will not spend any more time on it. We will move on to the actual circuit diagram, figure 2, instead.
Once again IC1 is clearly the heart of the circuit so we will start by looking at the functions of its most important pins.

■ Transmitted carrier, pin 8. The modulated signal that is to be transmitted is found at this pin.
■ Received carrier, pin 5. This is the input for the incoming analogue signal that must be processed by the modem.
■ $\overline{\text{RING}}$, pin 1. If this input is made '0' and DTR is also '0' the IC transmits a reply tone via TC to find out if is is being called by another modem.
■ $\overline{\text{RESET}}$, pin 3. A reset pulse is fed to this input from an RC network as soon as the power is switched on.
■ XTAL1, pin 24. As could be expected, this pin is the clock input for the IC. The clock signal is supplied by the crystal oscillator based on T1 and operating at a frequency of 2.4576 MHz.
■ MC0, MC1, MC2, MC3 and MC4, pins 17, 18, 19, 20 and 21 respectively. These inputs are used to enable the mode to be selected from the 32 different Bell or CCITT specifications available. A summary of these possibilities is given in table 1. In this modem we will only use the CCITT V21 and V23 modes so only MC0 and MC1 are connected to the 'switching logic'.
The normal communication between the AM7910 and a computer (or terminal) is conducted via the following pins:
■ $\overline{\text{Data terminal ready}}$, pin 16. This signal indicates that the terminal is ready to work with the modem. As long as the terminal and modem are communicating with one another this signal must be low.
■ $\overline{\text{Request to send}}$, pin 12. This indicates that the modem must switch to send mode. While data is being sent this input must remain low.
■ $\overline{\text{Back request to send}}$, pin 11. The back channel (in V23 mode) must also be switched to send, by means of this pin.

1

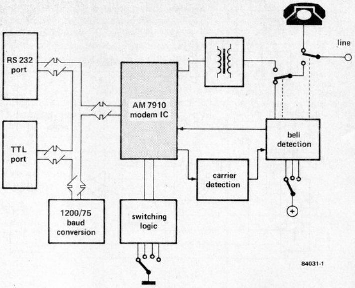


Figure 1. The heart of the modem is the AM7910 IC, which takes care of all the data transfer. All the other blocks are for what could be called extras.

Figure 2. Our 'single-chip modem' (IC1) needs quite a number of extra components to take care of interfacing, selecting different modes, baud rate conversion and so on.

This input is not, however, used for V21 mode. Note that $\overline{RTS}$ and $\overline{BRTS}$ may never both be low at the same time; in our circuit this is prevented by linking pin 11 to pin 12 via an inverter.

- Clear to send, pin 13. After the terminal has given an $\overline{RTS}$ signal this input goes low to indicate that the modem is ready to begin transmission.
- Back clear to send, pin 14. This pin has the same function as $\overline{CTS}$ except that it is for the back channel in V23 mode.
- Transmitted data, pin 10. The data that must be transmitted is presented to this input.
- Back transmitted data, pin 28. Data that must be sent via the back channel is fed to this input. This is only possible in

2

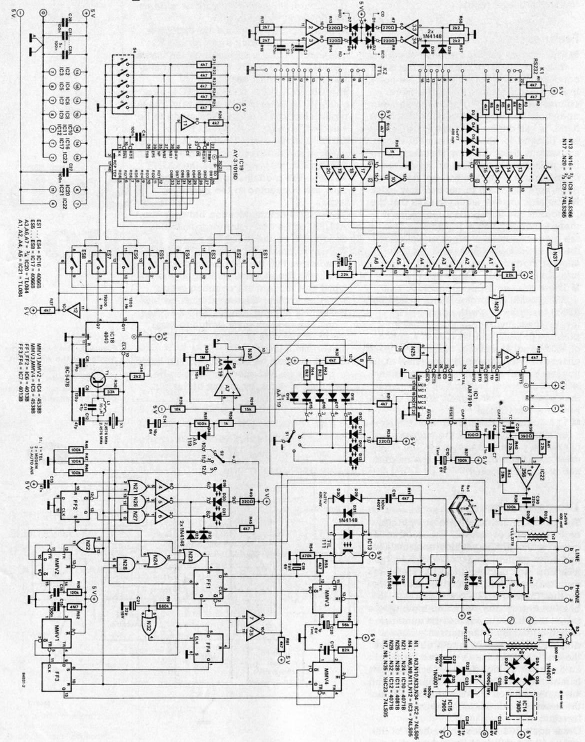


Table 1

MC4	MC3	MC2	MC1	MC0	
0	0	0	0	0	Bell 103 Originate 300bps full duplex
0	0	0	0	1	Bell 103 Answer 300bps full duplex
0	0	0	1	0	Bell 202 1200bps half duplex
0	0	0	1	1	Bell 202 with equalizer 1200bps half duplex
0	0	1	0	0	CCITT V.21 Orig 300bps full duplex
0	0	1	0	1	CCITT V.21 Ans 300bps full duplex
0	0	1	1	0	CCITT V.23 Mode 2 1200bps half duplex
0	0	1	1	1	CCITT V.23 Mode 2 with equalizer 1200bps half duplex
0	1	0	0	0	CCITT V.23 Mode 1 600bps half duplex
0	1	0	0	1	
0	1	0	1	0	
0	1	0	1	1	
0	1	1	0	0	Reserved
0	1	1	0	1	
0	1	1	1	0	
0	1	1	1	1	
1	0	0	0	0	Bell 103 Orig loopback
1	0	0	0	1	Bell 103 Ans loopback
1	0	0	1	0	Bell 202 Main loopback
1	0	0	1	1	Bell 202 with equalizer loopback
1	0	1	0	0	CCITT V.21 Orig loopback
1	0	1	0	1	CCITT V.21 Ans loopback
1	0	1	1	0	CCITT V.23 Mode 2 main loopback
1	0	1	1	1	CCITT V.23 Mode 2 with equalizer loopback
1	1	0	0	0	CCITT V.23 Mode 1 main loopback
1	1	0	0	1	CCITT V.23 Back loopback
1	1	0	1	0	
1	1	0	1	1	
1	1	1	0	0	Reserved
1	1	1	0	1	
1	1	1	1	0	
1	1	1	1	1	

Table 1. All the various different possible communications standards that the AM7910 can handle are indicated in this table. Selection is made with pins MC0...MC4.

V23 originate mode, otherwise BTD must be '1'.

- Received data, pin 26. The data received by the modem is available at this output.
- Back received data, pin 15. Data received by the modem on the back channel in V23 answer mode is available at this output.
- $\overline{\text{Carrier detect}}$, pin 25. When the carrier wave is present at the input of the modem this pin is low.
- $\overline{\text{Back carrier detect}}$, pin 27. This pin has the same function as $\overline{\text{CD}}$ except that in this case the carrier is received on the back channel in V23 answer mode.

The RS232 section of the circuit is seen at the upper left-hand side of the circuit diagram, complete with the 25 pin D-type connector. Details about both connectors (K1 and K2) are contained in table 2. Some of the pins (2, 4, 14 and 20) are connected to IC1 via an RS232 to TTL-level converter (R3...R6, D3...D6) and four three-state inverting buffers (to convert to the active low levels required). Signals from IC1 to the RS232 connector are inverted and converted to RS232 levels by op-amps A1...A6. There is no need for any level conversion in the case of the second connector but four three-state buffers are included after the inputs, pins 1, 2, 9 and 10. Remember that the output pins in the TTL connector have exactly the same signals as the outputs of IC1 and some of these are active low. Note that pin 3 in the TTL connector must be connected through to pin 8 (ground). When a connector is inserted into this TTL socket the input signals are fed to IC1 via N17...N20 and three-state buffers N13...N16 make the RS232 inputs high impedance. If both connectors are inserted into the modem K2 (the TTL connector) will therefore always have priority. When the UART, IC19, is converting a character from 1200 to 75 baud pin 7 of K2 feeds a busy signal ('0') to the terminal so that it will not transmit any new data. As soon as the transmitter buffer is empty TBMT (pin 22) goes high. The four LEDs are used to indicate various conditions: main channel carrier present (D1), back channel carrier present (D2), incoming data on main channel (D3) and incoming data on back channel (D4).

The baud rate converter, formed by IC18, IC19 and ES1...ES8, is only used in V23 mode. The clock signal provided by T1 is reduced to frequencies of 19,200 Hz (output Q7 of the 4040) and 1200 Hz (output Q11). These frequencies are sixteen times as high as the transmission rates of 1200 and 75 baud because the UART needs a clock frequency sixteen times as high as its transfer rate. The electronic

Table 2

	RS232/V24 pin	TTL-port pin
Transmitted Data	2	10
Received Data	3	12
Request to Send	4	9
Clear to Send	5	13
Data Set Ready	6	15
Signal Ground	7	8
Data Carrier Detect	8	4
Back channel Data Carrier Detect	12	11
Back channel Clear to Send	13	5
Back channel Transmitted Data	14	2
Back channel Received Data	16	6
Data Terminal Ready	20	1
RS232-TTL port switching	—	3
Busy signal during 1200 to 75 Baud conversion	—	7

Table 2. Most of the signals present on the modem's two connectors are common to both, but are on different pins.

switches are used to ensure that the data travels in the right direction. When a back carrier is detected the 1200 Hz clock is used for inputting data and the 19,200 Hz clock for outputting data. The back channel data is fed to the serial input of the UART, whose serial output goes to the 'back transmitted data' line in the two connectors. Characters are therefore input via the back channel at 75 baud and output at 1200 baud on the main channel. Data may also travel in the other direction on the two channels if the two clock connections as well as the serial input and output are interchanged. The 1200 baud data that the terminal wants to send on the back channel is now converted to 75 baud data by the UART. While it is doing this IC19 feeds a busy signal to pin 7 of the TTL connector. This conversion works for both connectors and has the great advantage that the terminal need only work with data at 1200 baud. This whole conversion section is not used at all when the modem is operating in V21 mode.

The next section we will deal with is the switching logic based around S1. Using this switch MC0 or MC1 or both can be grounded. This gives a choice of four different modes: 300 baud originate, 300 baud answer, 1200 baud originate and 1200 baud answer. LEDs D10...D13 indicate which mode has been selected. For 1200 baud transmission and reception only MC0 is zero. The change from transmission to reception, or *vice versa*, is made by switching the $\overline{RTS}$ and $\overline{BRTS}$ level (via N8, N31 and N9). Whenever a new switch position is selected the circuit around A7 and N30 supplies a short pulse to the $\overline{DTR}$ input of IC1 in order to reset this chip.

The bell detector section, which also takes care of the switching between telephone and modem, is quite extensive. The transmit and receive inputs of the AM7910 are connected to transformer Tr2. Although outgoing TC signals do not pass through IC22, incoming signals are amplified by this op-amp before being passed through to RC. The other winding of the transformer is connected to the telephone network via relays Re1 and Re2. In the output mode (when neither relay is operated) the telephone is linked to the line connection. Part of the reason for this set-up is to enable the telephone to be used normally when the modem is switched off. Whenever the power is switched on flip-flop FF2 is reset with the result that the selector circuit (N4...N6, N21, N22, N26, N27 and MMV2) will automatically select the 'telephone' position and neither relay will be operated. A relay can then only be operated when a different position is selected with switch S2. When this happens N22 triggers MMV2 and this monostable then sends a set pulse to FF2 causing it to deselect the obligatory ('telephone') position. If the 'modem' position is selected R1 is operated via N5 so the telephone is disconnected from the line. At the same time FF1 is set and Re2 is then operated

Parts list

Resistors:
R1...R6,R11,R12,R15,
R21...R27,R31,R32,R45,
R55,R59,R60,R61 = 4k7
R7,R8,R13,R14,R33,
R49 = 220 Ω
R9 = 680 k
R10 = 120 k
R16,R50 = 1 k
R17,R18 = 2k7
R19,R20,R40,R41 = 22 k
R28 = 18 k
R29 = 15 k
R30 = 1 M
R34,R57,R58 = 2k2
R35 = 100 Ω
R36 = 33 k
R37,R38,R46...R48,
R51 = 100 k
R39 = 390 Ω
R42 = 39 k
R43,R44 = 8k2
R52 = 4M7
R53 = 82 k
R54 = 470 k
R56 = 56 k

Capacitors:
C1 = 4μ7/6 V
C2,C3 = 470 n
C4,C15,C27,C28,
C31...C35 = 100 n
C5 = 10 n
C6,C7,C16,C17 = 1 n
C8 = 39 p
C9 = 120 p
C10 = 10 μ/6 V Ta
C11, C12 = 47 p
C13 = 47 n
C14 = 10 μ/6 V
C18 = 100 n/400 V
C19 = 2μ2/6 V
C20 = 1 μ/6 V Ta
C21 = 22 μ/16 V
C22, C23, C25 =
1000 μ/16 V (preferably with axial leads)
C24,C26 = 1 μ/6 V
C29 = 2μ2 MKC
C30 = 220 n

Semiconductors:
D1,D2,D7,D8,D10...D13,
D19...D21 = LED, 3 mm red
D3...D6 = 4V7/400 mW zener
D9,D14...D18,
D40 = AA119
D22...D24,D27,D28,D31,
D38,D39 = 1N4148
D25,D26 = 5V6/400 mW zener
D29,D30 = 27 V/400 mW zener
D32...D37 = 1N4001
T1 = BC547B
IC1 = AM7910 (AMD)
IC2,IC3,IC23 = 74LS05
IC4,IC5 = 4538B
IC6,IC7 = 4013B
IC8 = 74LS366
IC9 = 74LS365
IC10,IC12 = 4071B
IC11 = 4081B
IC13 = TIL111
IC14 = 7805
IC15 = 7905
IC16,IC17 = 4066B
IC18 = 4040B
IC19 = AY-3-1015D
IC20,IC21 = TL084
IC22 = LF356

Switches:
S1 = single-pole 4-way rotary wafer switch (break before make)
S2 = single-pole 3-way rotary wafer switch (break before make)
S3 = double-pole mains switch
S4 = 8-way DIL switch

Miscellaneous:
F1 = fuse, 500 mA, complete with PCB-mounting fuse holder
K1 = 25-pin D-type connector, female 90°
K2 = 15-pin D-type connector, female 90°
L1 = coil, 10 μH
Re1,Re2 = miniature 5 V relay
Tr1 = mains transformer, 8 V/375 mA
Tr2 = line transformer, type VLL3719
X1 = crystal, 2.4576 MHz in HC18 package
Case = Retex Elbox RE.3 *(Imhof-Bedco Standard Products Ltd.)*
Heatsink for IC14
1 off telephone plug and socket

via N7. The line is then connected to Tr2 and the modem can operate via the telephone network. In the 'auto' position only Re1 is operated (via N6) so in this case the line is linked to opto-coupler IC13 via R11, C18, D29 and D30. The telephone is now switched off but if a bell signal (about 75 V a.c. at 25 Hz) is detected the LED in the opto-coupler lights and causes the photo transistor to conduct. As long as the bell signal is present for at least the RC time of R55 and C19 MMV3 will be triggered. This feeds a clock signal to FF1, which, in turn, operates relay Re2 to connect the modem to the line. At the same time the modem receives a $\overline{\text{RING}}$ signal via N35 so IC1 initiates a procedure to find out if there is another modem connected to the line. If the carrier disappears in the course of a transmission this is detected by the action of N25, MMV1, FF3, FF4 and MMV4. If the carrier is absent for more than about a half second, or if the second modem does not transmit any carrier at all, the connection is automatically broken.

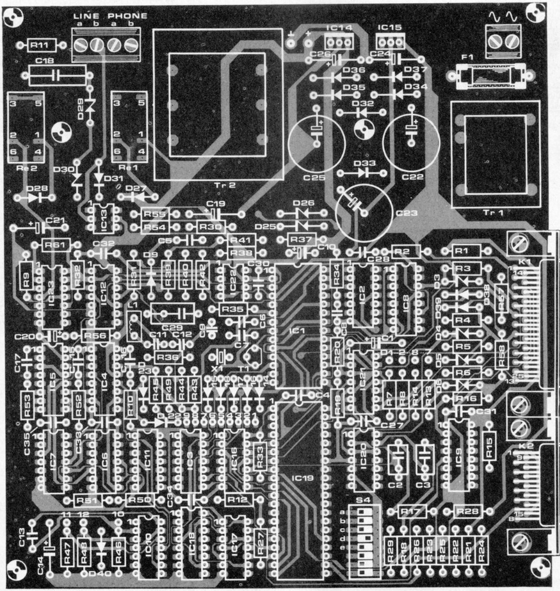
The power supply section is unremarkable. A pair of voltage regulators provide the necessary + and −5 V. Note that the transformer in the power supply will become warm in use; this is quite normal and nothing to become alarmed about.

Construction

Great care should be exercised when building this modem as it will be connected to the telephone network. The component overlay shown in figure 3 indicates where everything should be fitted, in the usual order. The relays are soldered directly to the printed circuit board. When all the components have

Figure 3. The printed circuit board for the modem is quite crowded but this does help keep the size small. The actual layout of the copper tracks is not shown here as the board is only available as part of a kit.

3



S1	pin 18	pin 17
300 baud originate	0 V	0 V
300 baud answer	0 V	5 V
1200 baud originate	5 V	0 V
1200 baud answer	5 V	0 V

been mounted on the board the case must be prepared. If the LEDs are fitted directly into the front panel each will require a hole of 3 mm diameter. If clips are used the holes should be 4.5 mm diameter. Suitable holes must also be drilled for the rotary switch spindles. The diameter will depend on the type of switch used. A number of holes and slots must be cut in the back of the case for the mains cable, telephone cable, two connectors and mains switch. The old carpenter's maxim of 'measure twice and cut once' is very appropriate here. After sticking the adhesive front panel to the case the LEDs and rotary switches can be fitted. There is no difficulty in wiring switch S2 as this is simply a matter of connecting it to points 10, 11, 12 and + on the board. The anodes of LEDs D19, D20 and D21 are linked together and this junction is then wired to point 9 on the board. The cathodes are connected to points 6, 7 and 8 respectively. Wiring S1 requires slightly more attention. The contacts of the switch must be connected to points 2, 3, 4 and 5 and to the cathodes of LEDs D10...D13, and the common pole is connected to ground. The anodes of the remaining four LEDs, D1, D2, D7 and D8, are first linked together and this common point is then fed to the + point on the board. The cathodes connect to points D1, D2, D7 and D8.

The mains cable can now be connected, via S3, to the board. The power can then be switched on and the voltages checked. If both positive and negative 5 V supplies are correct the power can be switched off again and the ICs (with the exception of IC1) inserted into their sockets. When the power is switched on again the 'telephone' LED beside the leftmost switch lights, and only when the switch is operated will a different LED light to indicate the position selected. The logic levels appearing at pins 17 and 18 of IC1 can be measured at S1 for the four positions that can be selected. The table in the margin here indicates what the levels should be. If this is correct the power can be switched off again so that IC1 can be inserted into its socket. Be careful when doing this as the AM7910 is an expensive IC and it can easily be damaged by static. Connect a telephone to the 'line' connection and select 'MODEM' with S2. (The white and blue wires in the telephone cable are connected to the points marked 'phone' on the board and the red and green wires go to the points marked 'line'.) If S1 is now switched a peep tone should be heard (after a few seconds delay) for each of the four positions. The 'AUTO ANSR' position is then selected with S1. Link pins 4 and 5 of IC13 (the opto-coupler) via a 1 k resistor and a tone should be heard for about 10 to 15 seconds. This should happen for all positions of S2. The tone's pitch varies gradually but this may not be noticeable in all positions. 'MODEM' is again selected and pin 2 of the RS232 connector is connected to −5 V. A change in pitch should be heard. This applies for the two 300 baud and the 1200 baud answer positions. For 1200 baud originate pin 14 is connected to −5 V via a 1 k resistor instead and this pin is then touched with a finger. Finally pin 20 is connected to −5 V and then no tone should be heard. If all these tests are correct then you can assume that the modem is working.

The operation of the circuit can be more carefully checked using an oscilloscope. To measure the output voltage start by disconnecting the modem from the telephone and connect a load of 600 Ω (560 Ω in series with 39 Ω) across the 'line' terminals. There should be an a.c. voltage of 275 mV_{rms} across this load. Next test to see if the right frequencies are being produced:

V21 ORIG: space = 1180 Hz
mark = 980 Hz
V21 ANSR: space = 1850 Hz
mark = 1650 Hz
V23 ORIG: space = 450 Hz
mark = 390 Hz
V23 ANSR; space = 2100 Hz
mark = 1300 Hz

The frequency of the reply tone (except for V21 ORIG, which does not give any reply tone) is always 2100 Hz. The start-up cycle can easily be followed on the oscilloscope: first there is 1.9 s of silence, then a reply tone for 3 s and then the mark or space tone.

The modem can now be placed into its case and the wiring tidied up but do not close it just yet. The DIL switches still have to be set: refer to table 3 to find the correct settings.

Using the modem

One point we have not yet mentioned is the communication between computer and terminal, which is very important because if this is not correct there is no way data can be transferred properly. This presupposes that the connection between computer and terminal will be a serial one. With a real terminal this is taken into account so all that is needed is an RS232 cable as the necessary communication software will already be available. The

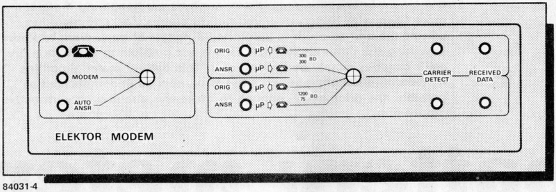
Table 3

Switch	Function
a	Parity: 0 = odd parity; 1 = even parity
b-ε	Number of bits per character
	c=0, b=0: 5 bits
	c=0, b=1: 6 bits
	c=1, b=0: 7 bits
	c=1, b=1: 8 bits
d	Number of stop bits: 0 = 1 stop bit; 1 = 2 stop bits
e	0 = parity bit present; 1 = no parity bit

'0' = switch closed
'1' = switch open

Table 3. A number of different character formats can be selected using DIL switches S4 located beside the UART chip (IC19).

4



84031-4

Figure 4. The front panel for the modem, which, as usual, is a thin self-adhesive foil, is not shown here full size due to space considerations.

Elektor universal terminal described in the December 1983 issue is an example of this. There is another possibility if you have a computer with an RS232 interface. The computer's handbook should advise about the signals present at the various pins of the RS232 connector and the software used to drive the interface. Some computers with an RS232 interface even allow operation at 1200 and 75 baud, which does away with the need for the baud rate converter in the modem. In this case IC16...IC19 can be removed and wire bridges can be used to connect pins 2 and 3 and also pins 9 and 10 of the IC16 socket. Some computers, unfortunately, do not have any serial connector so for these computers the only thing to do is to make a parallel port and write a small machine code program to control it. We will deal with this latter point in a very general sense to give an idea of how to go about writing this routine but each user will have to 'tune' our ideas to suit a particular machine. If this seems like a daunting task you may be lucky enough to find somebody in your computer club or user's group who already has such a routine. It may be better in any case to use an existing program if it is available as it is very important to standardise as much as possible when transmitting data over the telephone lines.

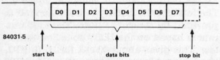
The first thing to decide is what format the character will have. The most common format uses 8 data bits for the character, preceded by a start bit (which is always '0') and followed by a stop bit (which is always '1'). If no data is being transmitted there is always a '1' on the line. The build-up of this sort of character is shown in figure 5, from which it is clear that bit Ø is transmitted first and bit 7 (the highest bit) last. In the Elektor modem transmission rates of 300, 1200 and 75 baud are possible. Other points to note are:

- Use a parallel I/O port on the microprocessor (and remember to connect pin 3 of the modem's TTL port to ground, pin 8).
- Initially the control signals are not used. The modem itself switches automatically to 'transmit'.
- One bit in the port is used as serial input and one bit is used as serial output.
- At the modem side the TTL-compatible port is used.
- The serial to parallel and parallel to serial conversions are carried out by means of a few software loops (with the necessary shift operations).
- It may prove advantageous to introduce a small change into the system to jump to an interrupt routine whenever a start bit appears. This is can be particularly useful in conjunction with scrolling.
- Ensure that the bytes read in are written to the correct memory locations.
- The output driver often ends with a RAM memory address and a RETURN. The address of the modem output driver is then stored at the position indicated by this return.
- The stop bit must not be used for test purposes as this costs too much processor time.
- Not all terminals can work with full-duplex but as long as this is taken into account at both ends of the telephone line it is not a problem.

These are the basic guidelines to keep to when writing the machine code routine. We have purposely not dealt with certain points such as recognising specific terminal commands as these are not necessarily standard. Note, however, that the busy line in the TTL port can be used when the UART is making a conversion from 1200 to 75 baud. An alternative for the parallel to serial conversion is to use an ACIA just as the 6551 was used in the CPU card published in Elektor in December 1983.

This sort of terminal or modem program can be as basic or as extensive as any particular user wants provided both sides of the line keep to the same protocol. Deciding this protocol within a user's group will make standardisation of programs for any processor much easier and will facilitate the exchange of data.

5



84031-5

Figure 5. This is the format usually used for a single character when transmitting serial information: one start bit is followed by the eight data bits and then one stop bit.

The advances in electronics and, in particular, the push towards ever greater miniaturisation means that our lives are becoming more and more filled with battery-powered radios, clocks, cassette recorders, calculators and so on. It is very often a matter of guesswork to know how long the batteries will last as it is not possible to estimate a dry cell's capacity simply by looking at it. This battery meter simplifies matters considerably and, as it has been kept as uncomplicated as possible, the price is low enough to make this circuit a very attractive proposition.

battery meter

indicates the approximate capacity of a dry cell

The more battery-powered equipment we use the more difficult it becomes to remember how old all the various batteries are. All the various aspects of Murphy's Law come into the equation and just in the middle of an important recording the batteries in your cassette recorder give up the ghost. (The law of conservation of energy immediately starts working, of course, with you rushing around trying to find some good batteries thereby compensating the universe for the energy no longer supplied by the batteries.)

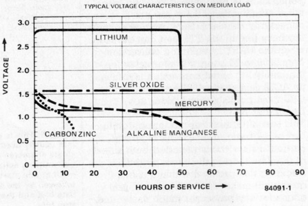
With all due respect for the Laws of Life it is a bit annoying not knowing the capacity remaining in a battery. A battery 'contents' meter is what is needed but this is not quite as simple to implement as it might appear at first sight. The first thing that must be determined is how the battery capacity is measured.

Looking for an answer to this question we note that batteries can be divided into two broad types. The first type consists of batteries that supply an almost constant voltage during their whole life. Examples of this type are lithium, mercury and silver oxide batteries, all of whose voltage drops so little (about 0.05...0.1 V) that it is virtually impossible to measure the remaining capacity as a function of the output voltage. Other methods are too complicated to enable a measurement to be made quickly so we must conclude that there is no simple way to estimate the contents of these batteries. This type of battery is used mostly in watches, calculators and cameras and, as the leakage is so small (only a few percent per year), it is probably best to leave the battery in the equipment until it fails and keep a replacement close at hand.

The second group of batteries includes the carbon zinc and alkaline manganese types, the first of these being much cheaper and more common. Most 'normal' batteries sold in the shops are carbon zinc types but recently the alkaline manganese types have been gaining popularity. The reason for this is that they last longer, which, the consumer hopes, makes up for the higher price. Both of these types display a marked voltage drop during their lifetime and this fact can be used to determine the capacity remaining in the battery. To do this we need a voltage meter that can provide fairly accurate measurements in the range of 1...1.5 V (per cell) and a suitable load (in the form of a resistor). This resistor is necessary to enable the terminal voltage of the battery to be determined at any point in its life, knowing that the internal resistance increases with decreasing capacity.

Figure 1. This chart shows that only carbon zinc and alkaline manganese batteries have a significant drop in output voltage over their life span. It is also interesting to note how much longer the expected life of the alkaline manganese battery is than the more common carbon zinc type.

1



The meter

As we stated at the beginning of this article the layout of this circuit is very simple. The method used does not give a perfectly accurate indication of the remaining capacity, but this was never the intention and it is hardly needed considering that the batteries in question are themselves not very accurate. Furthermore, accepting this slight 'imperfection' makes our task much easier. The circuit for the battery meter is shown in figure 2. The load for the battery to be measured is provided by resistors R1...R6. The load current is based on the IEC's so-called radio test. This gives about 20 mA for HP11, HP7, 'duplex' and 'normal' types, 40 mA for HP2

2

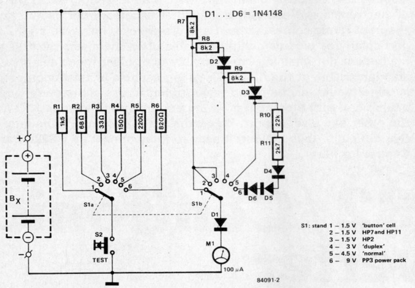


Figure 2. As the whole purpose of this circuit is to economise on 'battery expenditure' its price must be low enough to be quickly recovered. The meter is, in fact, the most costly component. Incidentally all empty batteries are harmful to the environment so they should be disposed of in the right place.

and about 10 mA for a PP3 9 V power pack. Alkaline manganese batteries are now being offered as an inexpensive alternative for silver oxide types so our meter includes a position (with a load current of 1 mA) to enable these cells to be tested. The meter section consists of M1, D1...D6 and R7...R11. A normal 100 µA f.s.d. moving coil meter is used for M1. A single diode (D1) and resistor (R7) are in series with the meter when measuring 1.5 V batteries. With the values shown the meter deflects fully at a voltage of about 1.6 V. The diode provides a threshold so that the measuring range of M1 lies from 0.6 to 1.6 V. This suits our purpose admirably as the voltages that interest us are from 1.5 V down to 0.8 V. This latter value is generally held by the battery manufacturers to signal the end of an alkaline manganese cell's life; the corresponding value for carbon zinc is 0.9 V.

This range may seem to be a bit limited given the different batteries we need to measure but the difficulty is overcome by 'spreading it' over almost the whole meter range. Different battery types are catered for by changing the resistance (from a minimum of 8k2, R7 only, up to a maximum of 49k3, R7...R11) and the number of diodes in series with this (from one, D1, up to six, D1...D6). The result of this is to change the effective range of the meter so it always shows a relative value (the 'contents' of the battery) rather than an actual one (the battery voltage).

Without a scale the meter is useless, so a scale suitable for M1 is given in figure 3. The white section indicates that the battery still contains more than half of its maximum capacity, grey shows that the battery is between half and completely empty and a reading in the black end of the scale can mean only one thing: the battery is flat. Two scales are shown: one for carbon zinc and the other for alkaline

3

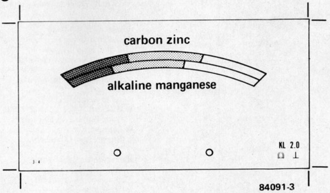


Figure 3. This scale should be used for the meter. The upper section is for carbon zinc batteries; the lower for alkaline manganese types.

manganese. For those of you interested in specific values, we classify 'half full' as 1.3 V for carbon zinc and 1.2 V for alkaline manganese. The 'empty' points are 0.9 V and 0.8 V respectively.

The battery meter is as simple to use as it is to make: connect the battery to be measured to the circuit's terminals and see if the meter deflects. If not either the battery is flat or its polarity is incorrect. In the latter case M1 is protected by D1. If the meter does deflect the test button must be pressed to connect the load across the battery. The reading on the meter then clearly shows the remaining capacity of the battery.

Note: more information about batteries can be found in infocard 62.

Nobody can seriously claim that the continuing progress in the field of electronics and computers is neither necessary nor useful. Progress rarely comes without any drawbacks, however, and, particularly as regards computers, this often manifests itself as new equipment not retaining compatibility with older machines or standards. One of the most frustrating aspects of this incompatibility is the difficulty encountered when trying to use some peripheral equipment with a computer where one of these has a parallel and the other has a serial port. This interface is designed to counter just this difficulty, thus making it easy to interconnect an RS232 and a Centronics port.

RS232 / Centronics converter

Characteristics
RS232 — Centronics converter with handshake signals.

Parallel to serial mode
- buffered Centronics input
  8 data lines
  Strobe/Busy/Acknowledge
- RS232 0 V/5 V or −12 V/5 V output
  Data Terminal Ready input

Serial to parallel mode
- RS232 0 V/5 V or −12 V/5 V input
  Data Terminal Ready output
- buffered Centronics output
  Strobe/Busy/Acknowledge

Format of the serial data
—5,6,7 or 8 data bits
—parity enabled/disabled
—1 or 2 stop bits
—error signals (parity, format and overflow)

Transmission speeds
—Two different speeds can be used during simultaneous parallel to serial and serial to parallel conversions.
—75 - 109.9 - 135 - 150 - 200 - 300 - 600 - 1200 - 1800 - 2400 - 3600 - 4800 - 7200 - 9600

a serial to parallel and parallel to serial converter... with handshake lines

The value of this parallel to serial and serial to parallel converter will be obvious from the list of characteristics given in the table here. A look at figure 1 shows that most of the various parts and functions are fairly self-evident so we will concentrate instead on a number of specific points.

Points to note

The serial output (pin 2 of the RS232 connector) and the DTR output (Data Terminal Ready, pin 20 of the RS232 connector) are switched by normal current sources (T1 and T2). Their low logic level can be changed by the user to suit the peripherals in use. (We will return to this point later.)
The DTR output is controlled by flip-flop N23/N24, which itself is fed by the DAV output signal (pin 19 of IC2) and the Centronics $\overline{\text{ACK}}$ or BUSY signals. In this way the flip-flop alternately indicates that the serial to parallel converter cannot receive any new information and then, after the converted data has been accepted by the Centronics peripheral, that the converter can again accept serial data. The format of the data during transmission (number of data bits, stop bits, etc.) can be programmed by means of switches S1...S5. Any errors detected during the conversion are indicated by LEDs D12...D14.
Glancing at figure 1 we notice input buffers N1...N9 and output buffers N10...N18 for the Centronics interface; figure 1b shows the oscillator used to generate the various different transmission speeds. To get a clear idea of the operation of the converter it is essential to study the internal structure of the AY-3-1015 UART (IC2) so we will have a quick look at that.
The basic blocks making up the UART are shown in figure 2. There is a block

1a

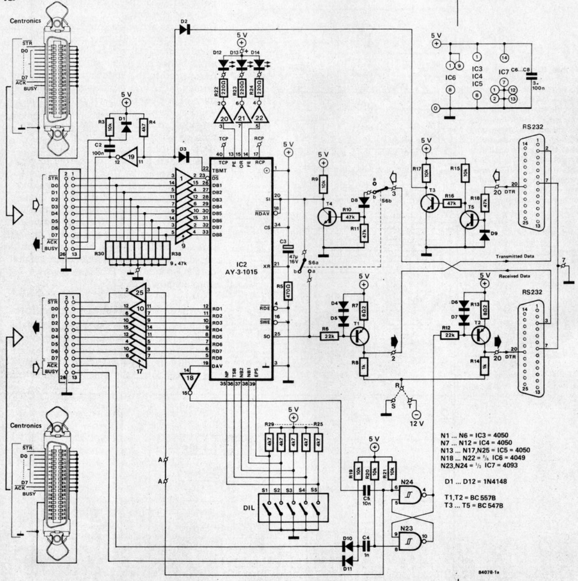


Figure 1a. This circuit can simultaneously carry out a parallel to serial conversion at a certain transmission speed and a serial to parallel conversion with a different baud rate. If the DTR line is not used during parallel to serial conversions it must be tied to +5 V.

marked transmitter (parallel to serial) and one called receiver (serial to parallel), each of which is separate and distinct from the other. The clock signals to these two sections can even be at completely different frequencies so the converter could also speed up or slow down the transmission rate (as we will see later). The data strobe signal (DS) causes the parallel data to enter the transmitter's input buffer, from where it is passed on to a shift register to start the conversion. Even before the conversion is complete the input buffer is freed so it can accept another 'word' of parallel data. The receiver, on the other hand, receives serial data into its shift register (even if the output buffer still contains the data from the previous conversion). The parallel data is transferred from the input shift register to the output buffer only at the end of the conversion, during the first stop bit, actually. After this transfer has been completed the UART sets the DAV (Data AVailable) line high to indicate that the parallel data is now present at the output.

The parallel to serial conversion

The process of the conversion is shown in figure 3. When the Centronics interface's data strobe line STR goes low the eight parallel bits are loaded into the input buffer and the TBMT (Transmitter Buffer eMpTy) line goes low to show that the UART cannot receive any more parallel data for the time being. This makes the Centronics BUSY line go high. The output shift register is empty so the data can be transferred there immediately. The conversion then starts; the TBMT line returns high as soon as the input buffer becomes empty and can receive new data. The BUSY line goes low again, taking the ACK

1b

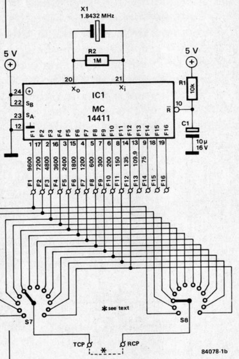


Figure 1b. Although we are particulary interested in the internal structure of the UART used in this circuit the oscillator, on the other hand, has little to attract our attention. Purely as an aside, note that the quartz oscillator frequency (F16) and half this frequency (F15) are present on pins 18 and 19. We do not, however, use either of these in our circuit.

line with it. This indicates to the peripheral that the converter has correctly received the data.

If new data arrives before the output shift register is empty (during the conversion, in other words) it will be loaded into the input buffer but must wait before being transferred to the shift register. The Centronics BUSY line remains high until this transfer is possible. Each parallel data word is loaded at the speed of the previous conversion so there is no loss of time or synchronization.

If the peripheral cannot accept the parallel data (which is converted to serial data) as fast as the UART can convert it this is immediately signalled by making the DTR line (pin 20 of the RS232 connector) low. Consequently, the BUSY line is made active, via T5, T3 and D2, so the flow of parallel data is stopped. If the DTR signal is never used (as happens when the serial data is received faster than parallel data is emitted) the DTR line must be kept permanantly high.

The serial to parallel conversion

Serial data reception starts as soon as the SI (Serial In) line first goes from high to low. Note, however, that the UART will recognize this as a start bit only if it lasts for at least a half bit. This high to low tran-

2

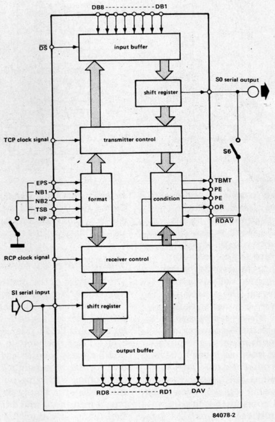


Figure 2. A look at the innards of the UART (Universal Asynchronous Receiver/Transmitter) shows the presence of two autonomous sections: one for the parallel to serial conversion and the other for the serial to parallel conversion.

sition of SI resets the DAV output line to zero via the $\overline{RDAV}$ line. This is necessary to ensure that after conversion the serial data can be transferred from the input shift register to the parallel output buffer, which must therefore be empty.
To call the output buffer 'empty' is a bit of a misnomer, in fact, as it is never actually empty. What is important is that the previous converted data, which is still present there, has already been read by the peripheral. The Centronics protocol demands that the peripheral signal when it has received data by means of a high to low transition on either the BUSY or the $\overline{ACK}$ line. The timing chart of figure 4 shows that the conversion is started as soon as the first stop bit is received. The UART's DAV line then goes high and activates the strobe output, $\overline{STR}$, on the Centronics interface. The RS232's DTR output line goes low, via flip-flop N23/N24, to signal to the source of the serial information that the previous data converted has not yet been loaded by the 'object' equipment. When this latter equipment does read the parallel data a falling edge appears either on the BUSY or the $\overline{ACK}$ line and flip-flop N23/N24 toggles. The DTR output line goes high again and this indicates that the converter is ready to receive more serial data. Note in passing that the DAV line could be reset by applying the falling edge of BUSY or $\overline{ACK}$ to $\overline{RDAV}$ instead of using the SI line for this.

3

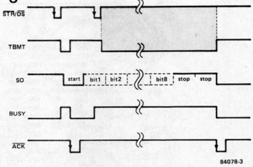


Figure 3. This is the timing of the data and handshake signals during a parallel to serial conversion. At the start the output shift register is empty; when the second word of data to be converted arrives the first word has still not been output.

4

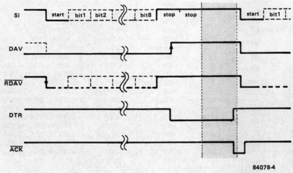


Figure 4. Timing of the signals during a serial to parallel conversion. Converting the second data word can only commence when the previous word has been accepted from the output (signalled by a falling edge on ACK).

If the DAV line has not been reset when the new serial data is transferred from the shift register into the output buffer the UART signals a pile-up of data by activating the OR (Over-Run) output. In our circuit the $\overline{RDAV}$ line is always activated by the new data's start bit so the OR error output will never be activated by the UART. The source of the serial data must therefore note the state of the converter's DTR output line.
The PE (Parity Error) output of the UART goes high whenever the receiver detects a parity error. If the NP (No Parity) line is high (S5 open), in which case there is neither an odd nor even parity bit, the PE output remains permanently low. The FE (Framing Error) output goes high if the receiver does not receive a valid stop bit.

Table 1

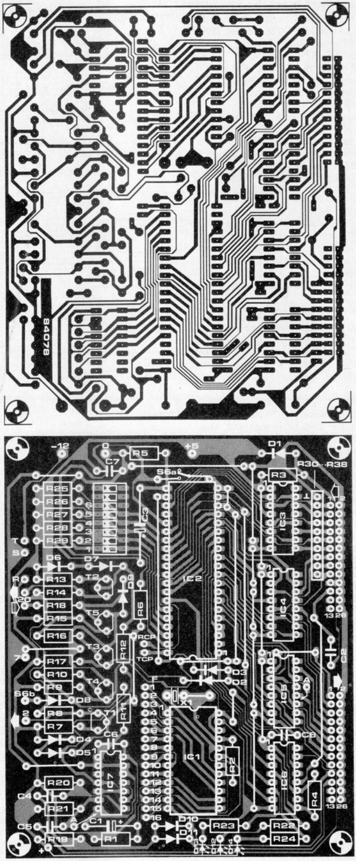
S1	open: even parity closed: odd parity	
S4	open: 2 stop bits closed: 1 stop bit	
S5	open: no parity bit closed: odd/even parity	
S2	S3	number of data bits
closed	closed	5
closed	open	6
open	closed	7
open	open	8

Obviously, these error signals only apply for serial input data. Programming the format of the serial data (with S1...S5, see table 1), on the other hand, applies for both reception and transmission. An interesting point about this programming is that it can be done either manually, with the switches, or via the output port of a microprocessor. The logic levels on lines EPS, NB1, NB2, TSB and NP are valid when the CS line (pin 34) goes high (in our case it is connected permanently to +5 V).

Construction and use

Having seen the protocol involved in this project, it is now time to deal with the actual hardware. When building the circuit on the board shown in figure 5 remember to interconnect the two points marked A, one between C1 and C5 and the other beside IC5. There are two possibilities for R30...R38: either an SIL

5



Parts list

Resistors:
R1, R3, R9, R15, R17, R19...R21 = 10 k
R2 = 1 M
R4, R25...R29 = 4k7
R5 = 470 Ω
R6, R12 = 22 k
R7, R13 = 8R2
R8, R14 = 1 k
R10, R11, R16, R18 = 47 k
R22...R24 = 220 Ω
R30...R38 = 47 k (may also be a single 9 × 47 k SIL resistor network)

Capacitors:
C1 = 10 μ/16 V
C2, C6...C8 = 100 n
C3 = 47 μ/16 V
C4 = 1 n
C5 = 10 n

Semiconductors:
D1...D11 = 1N4148
D12...D14 = LED, red
T1, T2 = BC557B
T3...T5 = BC547B
IC1 = MC14411 (Motorola)
IC2 = AY-3-1015 (see text)
IC3...IC5 = 4050
IC6 = 4049
IC7 = 4093

Switches:
S1...S5 = 8-way DIL switch (3 ways unused)
S6 = double-pole toggle switch
S7, S8 = single-pole 12-way wafer switch

Miscellaneous:
X1 = quartz crystal, 1.8432 MHz
1 off 25-pin D-type (RS232) male connector
1 off 25-pin D-type (RS232) female connector
2 off 26-pin male sockets (for female ribbon cable connector)

Figure 5. All the components from figures 1a and 1b are fitted to the same printed circuit board, except for the two rotary wafer switches. These are not needed if a fixed baud rate is used, in which case it will be necessary to connect points RCP and TCP to the appropriate output of IC7 by means of a short length of wire.

network or nine discrete resistors with one common side simply connected together in the air and with a separate wire to the board. Similarly, diodes D12...D14 have their anodes commoned and connected to +5 V. Be careful with the wiring of switch S6; when S6a is open S6b must be closed, and *vice versa*. The serial data input ('3' on the diagram of figure 2) is called S6b on the component overlay for the printed circuit board; this is, in fact, the common pole of switch S6b. The current consumption is about 50 mA (at +5 V) and this may possibly be drawn from certain Centronics outputs (refer to your user's manual). The −12 V is only needed for serial output signals where the receiver is unable to distinguish between ground potential and the logic level defined as zero volts. In that case a wire bridge will have to be used to join R to T (instead of R to S). Inputs SI and DTR are just as happy with logic levels between 5 V and 0 V as between 5 V and −12 V. There are various 'equivalents' or predecessors of the AY-3-1015, such as the AY-5-1013 or MM5303, that could also be used in this circuit provided the −12 V is applied to their pin 2.

Should you wish to modify or add to this circuit it may be useful to note that there are two unused Schmitt trigger NAND gates and a buffer in IC6 and IC7.

Now that the circuit has been built all that remains is to learn how to use it. The three fundamental ways of using the converter are indicated by figure 6. In figure 6a a computer transmits serial data to a printer with a parallel input. The numbers given correspond to those for a D-type connector on an RS232 interface and for a Centronics interface. In figure 6b it is the printer that has a serial input while the computer has a parallel output. If the clock signal (sixteen times the frequency for the desired transmission rate) is applied to the receiver section (the UART's RCP input) in the first of these two examples it is fed to the transmitter section (TCP input) in the second case. Note that in figure 6c the clock signal is applied simultaneously to inputs RCP and TCP. The real interest in this format lies in using two different frequencies for the two clock signals, to cause the transmission rate to be increased or decreased. In this case the converter's Centronics output must be connected to its own Centronics input (handshake lines included). It is very important to look at the DTR line before each new serial data is emitted if the transmitter speed is greater than the receiver speed.

Finally, a word about the function of S6. This switch allows the serial data emitted by the UART to be fed right back to its own input. For this so-called 'local mode' S6a is then in position 'a' and S6b in position 'b'. This permits any errors in the serial output signal (such as PE or FE) to be detected. If the DTR input line has been forced high the OR output remains inactive and LED D13 does not light.

6a

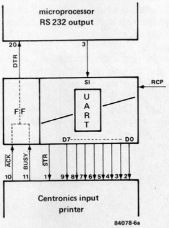


Figure 6a. Here the converter is used between a serial output and a parallel input. The pin numbers used correspond to the layouts generally used for this sort of connection.

6b

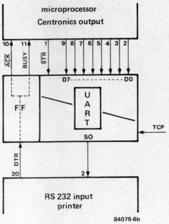


Figure 6b. In this case the converter is connected between a parallel output and a serial input. For the Centronics interface both ACK and BUSY signals are shown but in practice only one of these will be used at a time.

6c

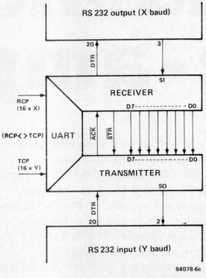
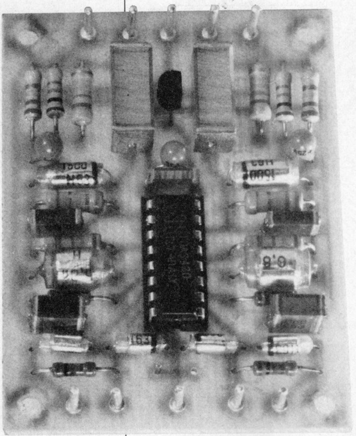


Figure 6c. If the Centronics output data is fed back to the Centronics input and two different clock frequencies are used for RCP and TCP the converter either increases (TCP > RCP) or decreases (TCP < RCP) the baud rate.



The design incorporates a few special characteristics that make it a little more than just another pre-amplifier. It is intended primarily for fitting in the record player. Such an arrangement precludes the use of a long feeder cable between the pick-up and the main amplifier. A lengthy feeder cable is a source of hum and adds a considerable capacitive load across the pick-up. Because the length of the cable would vary from installation to installation, it would be impossible to put a value to the capacitance. Yet, to achieve a straight frequency characteristic, it is imperative that the pick-up is terminated into the correct impedance. The inductance of the pick-up coil and the input capacitance of the pre-amplifier form a resonant circuit, the frequency of which is used by the manufacturers to get the high-frequency end of the characteristic right. A capacitive mismatch therefore causes either a premature fall-off in high frequencies or a peak that is shifted towards the centre of the characteristic.
Because the present pre-amplifier does not use a long feeder, matching between the pick-up and amplifier can be optimized.
Since the amplifier is mounted on board the record player, it becomes possible to use a symmetrical input circuit. This further reduces the likelihood of hum and saves an input capacitor.
The de-emphasis characteristic meets the relevant requirements of the IEC (International Electrotechnical Commission) and has been adopted by virtually the whole of the recording industry in the western world and such organizations as the AES (audio engineering society), the RIAA (record industry association of America), and the NARTB (national association of radio and television broadcasters).
The unit is easily modified to provide a normal asymmetrical input, enabling it to be built into the main amplifier instead of the record player. It can also be built as a microphone amplifier by omitting the de-emphasis circuit.

dynamic pre-amplifier

for magnetic pick-ups

It is not all that long ago that we published a pre-amplifier (MC/MM phono preamp — May 1983, page 5-18), but that was intended as part of the XL audio series. None the less, there is always interest in this type of unit, so we continued experimenting and the results are covered in the following pages.

Some background theory

There are two fundamental types of recording: constant-velocity and constant-amplitude, a combination of which is generally used.
In constant-velocity recording, if different frequencies at the same level are processed in turn by the recording amplifier, each drives the recording cutter with the same maximum velocity during each audio cycle. This type of recording cannot be used, however, below about 500 Hz

because it is accompanied by an increase of amplitude which is inversely proportional to the frequency, with the result that the usual spacing of grooves (about 100 μm) would be inadequate.
In constant-amplitude recording, different frequencies at the same level are processed so that they have the same maximum amplitude on the record. In this type of recording, the maximum velocity is proportional to the frequency because the stylus has to traverse the given amplitude in less and less time as the period is reduced. Therefore, in constant-amplitude recording, the velocity doubles each time the frequency is doubled. For each octave increase in frequency, there is a 6 dB increase in velocity, corresponding to a 30 dB greater velocity at 16 000 Hz than at 500 Hz. This is a substantial pre-emphasis, but not sufficient to result in the required recording characteristic. That is achieved by electrical means in attenuating the low frequencies and boosting the high frequencies as shown by the recording pre-emphasis characteristic in figure 1. It should be noted that the high-frequency boost results in a much higher signal-to-noise ratio on playback (thus considerably reducing the surface noise).
To obtain a uniformly flat frequency response during playback, the pre-amplifier must boost the bass frequencies and attenuate the high frequencies according to the playback de-emphasis characteristic shown in figure 1. Note that the de-emphasis characteristic is the inverse of the recording pre-emphasis characteristic. The curves are characterized by three time constants associated with the low, middle, and high frequency regions of the audio spectrum respectively.
The de-emphasis characteristic may be obtained in several ways: by passive networks either preceding or following the amplifier; by suitable feedback loops; or by a combination of these. The block diagram in figure 2 illustrates the latter solution: a low-noise amplifier with symmetrical input is followed by a low-pass filter with a time-constant of 75 μs, corresponding to a turnover frequency of 2120 Hz. This is followed by a second amplifier with a frequency-dependent feedback loop, which gives time-constants of 3180 μs and 318 μs, corresponding to turnover frequencies of 50 Hz and 500 Hz respectively.

Circuit description

The pre-amplifier is based on a type TDA 3420 IC, which has been designed for applications in good-quality stereo audio systems. Each channel consists of two independent amplifiers: the first one has a fixed gain (28 dB) while the second is an operational amplifier for audio applications.
With reference to figure 3, the sym-

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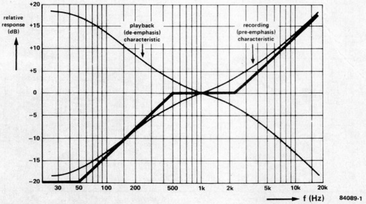

Figure 1. The IEC recommended recording and playback characteristics have been adopted by most of the record industry in the western world and also by organizations like AES (audio engineering society), RIAA (record industry association of America), and the NARTB (national association of radio and television broadcasters).

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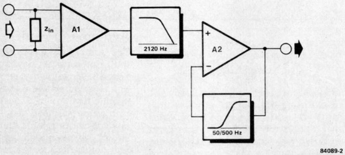

Figure 2. High-frequency correction in the dynamic pre-amplifier takes place after the first amplifier stage, while low-frequency correction is incorporated in the negative feedback loop of the second amplifier. An input capacitor is not necessary due to the symmetrical input.

metrical input is connected between pins 6 and 7 (the pin numbers in brackets refer to the second channel). The pick-up is loaded by the parallel combination of R1 and C1. The resistor, which is of the metal film type to reduce noise voltages across it, has a value about twice as high as is usual in a pre-amplifier and this is because it is shunted by the impedance of about 100 k between pins 6 and 7. The capacitor is also higher than normally found in this type of circuit, but this is to compensate for the omission of a feeder cable between pick-up and pre-amplifier. This cable normally has a capacitance of a few hundred picofarad. The values of R1 and C1 may, of course, be changed according to the particular type of pick-up used.

Network R2/C3/C4 provides a time-constant of 75 μs, corresponding to a turnover point of 2120 Hz. The other two turnover points are provided by amplifier A2 and its negative feedback loop. Amplification at low frequencies is high due to resistors R6, R5, and the parallel combination R3/R4. It decreases at higher frequencies because the (diminishing) reactances of C5 and C6 shunt R6. DC amplification is fixed at about 8 dB by R6, R5, and R3. As the d.c. output voltage of A1 (A1') is about 2.8 V, that of A2 (A2') becomes just about half the 15 V supply voltage which ensures an optimum dynamic range.

The supply voltage is stabilized by IC2, a type 78L15 voltage regulator. The input to this IC may conceivably be taken from the field winding of the record player motor. If this is not possible, a supply line may be taken from the main amplifier, or a simple power supply added to the pre-amplifier. Current consumption of the pre-amplifier amounts to a mere 10 mA.

As stated earlier, the input circuit may be made asymmetrical, which may be propitious if the circuit is built into the main amplifier, particularly if this has only one signal line per channel. The circuit then becomes as shown in figure 4. It is necessary to reduce the value of C2 because it is shunted by the capacitance of the feeder cable. The d.c. amplification of A2 (A2') is somewhat smaller because the d.c. output voltage of A1 (A1') is reduced by the omission of the connection to pin 6.

Application as linear (for instance, microphone) amplifier with symmetrical input is illustrated in figure 5a and with asymmetrical input in 5b. That in 5a is to be preferred because it makes it possible to connect a symmetrical microphone without an input transformer. Note that in both figures the components determining the de-emphasis characteristic have been omitted. The d.c. amplification of A2 (A2') has been suitably altered. The 680-ohm resistor is necessary for matching the microphone output.

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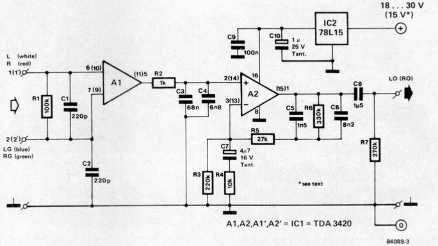


Figure 3. The circuit diagram given here is only for one channel: A1 is a low noise pre-amplifier stage with internal feedback and a predetermined gain of about 28 dB. A2 is an operational amplifier. Total gain at 1 kHz is of the order of 40 dB.

4

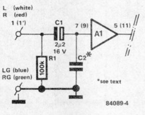
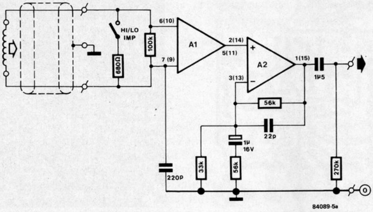


Figure 4. The input stage of the pre-amplifier has here been arranged in asymmetrical configuration. Capacitor C2, in conjunction with the capacitance of the cable between pick-up and input circuit, serves to match the cartridge and input impedances. The resistor in the R3 position must be reduced to 120 k to ensure an optimum dynamic range.

And now to work

The component layout and track side of the printed circuit board are shown in figure 6. As you will see, the printed circuit is intended for a stereo amplifier with symmetrical inputs. Construction of the printed circuit itself should not present any special problems, but good care should be taken with the installation in, and connecting to, the record player. The symmetrical input makes it necessary that

5a



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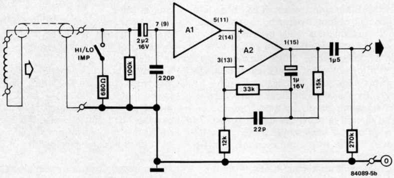

Figure 5. The pre-amplifier in linear configuration for microphone signals. The input may be symmetrical (5a) or asymmetrical (5b).

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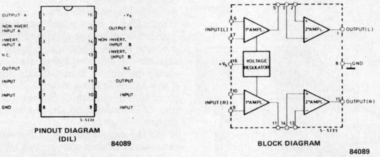

Figure 8. The TDA 3420 in schematic form.

the screens of the signal lines are not connected to earth. A look at the pick-up cartridge shown schematically in figure 7 shows that four differently coloured pins emerge from it: white and blue for the left channel and red and green for the right channel. These are taken to the connecting box at the turntable via wires running through the tone arm. At the connecting box the blue and green wires are connected to earth and these must be disconnected and then connected to terminals 2 and 2'. The white and red lines should be connected to terminals 1 and 1' respectively.

The metal casing of the cartridge is often connected to the blue or green pin by a small tag to ensure it is earthed. With a symmetrical input this connection must be broken but it is essential that the casing remains earthed. If a tag has been used, it may be easy to undo the connection. If

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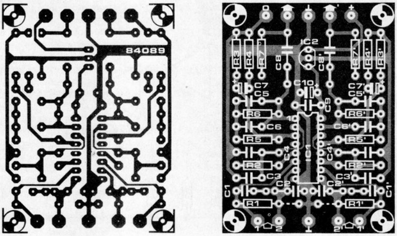


Figure 6. The printed circuit of the pre-amplifier with symmetrical input circuits. With suitable modifications, the other versions of the unit may be built onto the same boards.

Parts list
Symmetrical version

Resistors:
R1,R1′ = 100 k, metal film
R2,R2′ = 1 k, metal film
R3,R3′ = 220 k
R4,R4′ = 10 k
R5,R5′ = 27 k
R6,R6′ = 27 k
R7,R7′ = 270 k

Capacitors:
C1,C1′,C2,C2′ = 220 p, polystyrene
C3,C3′ = 68 n, plastic foil
C4,C4′ = 6n8, polystyrene
C5,C5′ = 1n5, polystyrene
C6,C6′ = 8n2, plastic foil
C7,C7′ = 4µ7/16 V tantalum
C8,C8′ = 1µ5, plastic foil
C9 = 100 n polyester
C10 = 1 µ/25 V, tantalum

Semiconductors:
IC1 = TDA 3420
IC2 = 78L15

Changes for asymmetrical version:
R6,R6′ = 120 k
C1,C1′ = 2µ2/16 V tantalum

there has not, check whether there is an internal connection between the casing and the blue/green wires. If so, there is a slight risk of hum occurring. In that case, make sure that the metal cartridge is isolated from the remainder of the tone arm by, for instance, fitting the cartridge in a nylon or polyester headshell. If hum still occurs (is the tone arm earthed properly?), try the asymmetrical input. This may be done simply by modifying the input circuit as shown in figure 4. The printed circuit track to pin 6 (10) of the IC should be cut with a track cutter or sharp pen knife.
Because with an asymmetrical input the d.c. output voltage of A1 reduces to about 1.5 V, the amplification of A2 has to be modified to retain the optimum dynamic range. This is accomplished by replacing the 220 k resistor in the R3 position by one of 120 k.
All capacitors, except C7, C7′, and C10, are polystyrene or plastic film types because of the small tolerances available in these.
The outputs are conventional stereo: left and right channels and earth. They should be connected to the LINE or DIN input of the amplifier (for instance, 'aux'). DO NOT use the MD input because this would result in a double de-emphasis correction as well as serious overloading of the amplifier.
Power supply requirements are fairly lenient, particularly since the pre-amplifier has a built-in voltage regulator. The (unregulated) input voltage may lie between 18 and 30 V. In many instances this voltage may be taken from the field winding of the record player motor. If that is not possible, you will have to construct a supply from a small mains transformer (current requirement is only about 10 mA), a bridge rectifier, and a smoothing capacitor. It may also be possible to obtain the supply from the main amplifier. If this happens to be about +15 V (maximum 18 V — regulated), the two extreme pins of IC2 should be shorted by a wire bridge.
When the supply voltage is derived from the main amplifier, take care to avoid earth loops. The negative line of the supply circuit is almost certainly connected to earth, and therefore to the input circuit screening, in the main amplifier. The negative line in the pre-amplifier is also connected to earth. In this situation, the braid of the screened cable in either the main or the pre-amplifier must be disconnected from earth.
The unit may be constructed as a linear (microphone) amplifier on the same printed circuit board. The circuit diagram for this configuration is given in figure 5 which shows that in certain positions different value components must be fitted or omitted altogether.

7

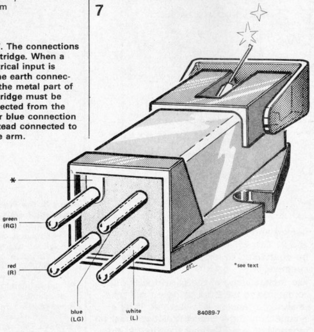


Figure 7. The connections to a cartridge. When a symmetrical input is used, the earth connection of the metal part of the cartridge must be disconnected from the green or blue connection and instead connected to the tone arm.

h-l logic tester

This is a TTL logic probe which, instead of the usual LED to indicate the logic states, uses a seven-segment Minitron or LED display to indicate 'H' for a high or '1' state and 'L' for a low or '0' state. The circuit also detects when the probe input is open-circuit and the readout is suppressed, thus indicating that contact with the desired test point has not been made. This avoids the false readings that may occur with some types of probe when the input is not connected.

The circuit makes use of a 7447 decoder driver. The input circuitry to this IC is designed so that when the input to the probe is high a '1' is applied to the 'C' or 4 input of the IC. When the input to the probe is low a '1' is applied to the 'A', 'B' and 'D' or 1, 2 and 8 inputs of the IC. This results in the display of the number 4 and the symbol ⊐ respectively in accordance with the truth table for the 7447. However, the connections from the outputs of the IC to the segments of the display are rearranged so that the display is actually H and L. When the input to the probe is open-circuit all four inputs to the 7447 are high (A = B = C = D = 1, i.e. '15') and the display is completely suppressed.

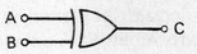
The input circuitry operates as follows: N_1 and N_2 are exclusive-OR gates. When a '0' is applied to the probe input both inputs of N_1 are '0' so the output is also '0'. One input of N_2 is held at '0' via R_1 and the other is held at '1', by R_2, so the output is '1'. This output is connected to the A, B and D inputs of the 7447. When the probe input is '1' one input of N_1 is '0' and the other is '1', so the output is '1'. This output is connected to the C input of the 7447. Both inputs of N_2 are '1', so the output is '0'. When the probe input is open-circuit the input of N_1 is not connected to ground floats at just above the '1' threshold level, so the output is '1'. The forward voltage drop of D_1 and D_2 prevents this from holding the input of N_2 high, so the input is held low by R_1. The other input is, of course, held high so the output is '1'.

1

7447 output	pin No.	connected to display segment
a	13	not connected
b	12	c,g
c	11	e
d	10	d
e	9	not connected
f	15	b
g	14	f

Truth Table for exclusive-OR gate

A	B	C
0	0	0
0	1	1
1	0	1
1	1	0



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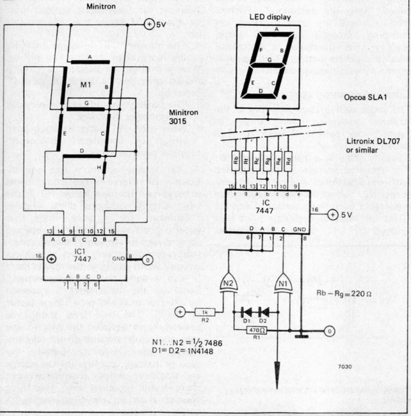

Figure 1. Connections from outputs of 7447 to display segments.

Figure 2. Complete Circuit of the H-L tester, showing the alternative connections for Minitron and LED display.

how to recycle dry cell batteries

facts and figures about a controversial subject

'Reviving dry cell batteries' is a topic which often comes up in electronics magazines and professional 'shop-talk'. Remarkably perhaps, so little is known about the subject that it seems to give rise to nothing but speculation. On the basis of our experience with batteries, we will try to establish a few facts to solve the mystery.

To start with, a dry cell battery cannot be recharged like an accumulator.
It is however possible to reactivate dry batteries by means of a corresponding similar 'charge process', that is to say, by reversing the capacitance loss which occurs during discharge to a certain extent. Since 'charging' a dry battery is much more complicated than a nicad cell, it is impossible to revive one when it is almost totally discharged.
The first attempts to regenerate dry batteries date back to the twenties. In the past there were all sorts of devices for this purpose, but their operation usually led to unsatisfactory results, which is why these 'chargers' have all disappeared from the market.

Disposable batteries nevertheless use up a great deal of energy and raw materials, which could be saved by regeneration or electrochemical recycling. Recently, a magazine in East Germany published a series of articles on the subject. Telefunken is manufacturing portable radio's including a recycling circuit called 'long life technique'. Battery manufacturers are also working on recycling projects. One of them, Mallory, has developed a successful alkali manganate battery to be available on the American market soon.

Looking at some specimens

The most well known example is the 'classical' recycling circuit shown in figure 1, for which E. Beer holds a patent.
Basically, this is a half-wave rectifier. The rectified voltage is superimposed with an additional alternating current across R2. During the positive half-wave a charge current flows across D1 and R1 (R2's influence is negligible since it is bridged by D1). During the negative half of the AC waveform. D1 will be high impedance, so that a discharge or 'reverse' current passes across R1 and R2. The value of R2 would normally be ten times the value of R1. The voltage of the recycling current is preset so that the peak value is not higher than the normal voltage of a new cell.
The superimposed alternating current should cause the dissolved zinc to be deposited in a more even and dense layer on the inside wall of the container than when recycling is carried out with a direct current only.
In the Varta battery handbook the procedure for a successful recycling has been summarised as follows:

a. The peak value of the charge voltage may not rise above 1.7 V per cell.
b. The recycling current is determined by the size of the cell and should be between 1/4 and 1/3 of the battery's discharge current.
c. The recycling time required is about 4.5 to 6 times the preceding discharge time, as, due to the low efficiency, the reactivating current must be about 50% larger than the amount lost.
d. The shorter the discharge interval, the more effective recycling will be. During a discharge period the battery should only lose a tenth of its total capacity.
e. The battery should best be recycled straight after discharge.
f. When dry cell batteries have been almost or completely discharged, they can never be recycled.

As far as the optimum size and efficiency of reverse current components is concerned (current across R2 in the basic circuit) opinions differ widely. Telefunken, for instance, finds that equally good results may be obtained using direct current only, since in practice recycling is very hard to achieve anyway. With regard to the results there is also a good deal of disagreement. Some say the capacitance is increased by a factor of 3 and others by a factor of 30 (!). The true level should be somewhere in between the two. In any case, the results depend on the 'circumstances' (the size of the battery, the type of battery, duration of the charge and discharge periods, interval between charging and recycling, etc.). One thing however is certain: recycling lengthens a battery's life-span.

1

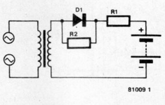

Figure 1. A simple but effective recycling circuit.

2

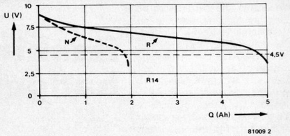

Figure 2. Tests show that recycling can increase the operational hours of a penlight cell by a factor of 3.

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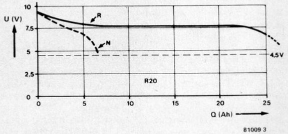
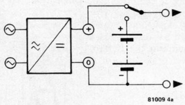


Figure 3. Recycling tests on a standard cell showed an increase of up to a factor of 4 in the operational hours count.

4a



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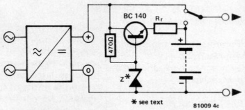

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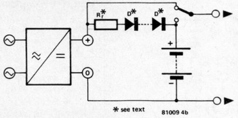

Figure 4. These circuits can be used to extend the life of batteries in portable equipment provided they have a built in mains power supply. Changeover from mains to battery (a) can be automatic via a mains connection socket switch.

Which batteries can be recycled?

Generally speaking, most types of zinc carbon batteries ('normal' dry cells) can be recycled with successful results. This is not the case with 'high power' batteries since tests on these have proved inconclusive.

The alkali manganate and mercury types should also be able to be recycled, but so far experiments have come up with nothing definite. It is not advisable to try recycling mercury batteries due to the danger of poisoning when mercury leaks out. Even more dangerous, in fact lethal, would be to recycle lithium cells – these are highly explosive!

Tests

It might be interesting at this stage to examine the tests carried out at Telefunken and the results that were obtained.

During an extensive series of experiments six batteries (nominal voltage 9 V) were subjected to four hours' operation (charging the battery with a charge resistance of 82 Ω) and 20 hours' rest every day. The batteries to be recycled were connected to a constant direct voltage of 9.5 V across a charge resistance of 47 Ω during the 20 hour period.

From figures 2 and 3 it can be seen that the dischargeable capacitance (operational hours count) in penlight baby cells may be increased by a factor of 3 and in single cells even by a factor of four. The high power type on the other hand showed no increase in capacitance worth mentioning.

All in all, therefore, normal cells can be recycled and used at very low cost per operational hour, provided the equipment they are in is mostly connected to mains.

Circuits

The following circuits to be discussed here were designed on the basis of Telefunken's experiences with direct current charging.

They can be incorporated into any portable device (such as a transistor radio cassette recorder) that includes a built in mains power supply. Switching from battery power to mains can be done either manually or automatically by plugging the supply cable into its socket (see figure 4a). For recycling purposes, the same switch will now be bridged by the charge resistor R_r and the diodes switched in series (see figure 4b). The most important requirement which must be met during recycling is that the charge voltage must not be higher than that of a fresh battery (1.7 per cell) to prevent it from being overcharged. If the open-circuit voltage of the power supply (which must be measured!) is higher, it will have to be limited with diodes to a

value between 1.5 and 1.7 x the number of cells for recycling to take place. There is a drop in voltage of about 0.6 V per diode.
Let's look at an example: a device fed with 9 V battery voltage is to be converted for recycling. The open-circuit voltage of the built-in power supply is measured at 10 V. Thus, the maximum charge voltage will be: number of cells x1.7 V = 6 x 1,7 V = 10.2 V. In this case it is not necessary to use diodes. It would be a different matter if the power supply were to produce an open-circuit voltage of 11 V, for example. Then diodes will have to 'lose' at least 0.8 V. Since the drop in voltage of a diode with 0.6 V would be too small, 2 diodes are used. This gives a maximum charge voltage of 11 V − 1.2 V = 9.8 or 1.63 V per cell. If the power supply voltage is below the nominal battery voltage, recycling will not be possible.
The charge resistance should be set at about 5 Ω per volt of battery voltage. Thus, for the most commonly used battery voltages the following values may be calculated: 12 V/68 Ω; 9 V/47 Ω; 7.5 V/39 Ω; 6 V/33 Ω and 4.5 V/22 Ω. For miniature cells the value of the charge resistor should be doubled.
Of course the charge voltage can also be limited by a small stabiliser circuit (instead of the diodes), as shown in figure 4c. Again, the zener diode voltage is chosen not to exceed the maximum charge voltage of 1.7 V per cell. The zener diode voltage will then be about 0.6 V higher than the maximum charge voltage. To enable the batteries to be recycled for as long as possible an excessive discharge must be avoided. This can be achieved by the circuit in figure 5, which switches the battery off when a voltage of about 1.2 V per cell is reached.
The zener diode voltage must be calculated as follows: number of cells x 1.2 V − 0.6 V. The zener voltage shown is valid for 9 V batteries and the system is switched off at 7.4 V. If discharge is to continue below this limit a switched bridge (drawn as a dotted line) can be included.
A design for a recycling power supply is shown in figure 6, again for an output voltage of 9 V. The maximum output current is 500 mA.
During mains operation a recycling current flows through diode D2 and charge resistor R_r. The supply current for the connected load will pass via diode D3. When the mains supply is switched off, switch S1 will enable T2 to conduct and the battery will switch on. If the battery voltage drops below a value of about 7.3 V, both T3 and T2 will turn off thereby switching off the battery. Diode D2 now prevents the battery from discharging any further via R_r. If in exceptional cases the battery is to be further discharged (for instance if there is no mains supply within reach) switch S1 can be used to bridge T3 and maintain the battery supply. ◀

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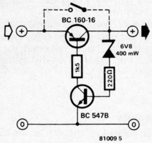

Figure 5. This circuit will avoid an excessive discharge by switching the battery off when a cell voltage of 1.20 is reached.

Sources:
Deussing, G.: Energy supply for Telefunken transistor radio's. Telefunken-Sprecher, no. 66, Feb. 1975, p. 26-28.
Huber, R.: Dry cell batteries. VARTA technical series, vol. 2, 1968, p. 110-112.
Glöckner, G., Petermann, B. and others: 'Recycling batteries using a symmetrical alternating current charge — problems and results of experiments'.
FUNKAMATEUR 28 (1979), nos. 2, p. 73; 3, p. 127; 4, p. 187; 5, p. 238; 6, p. 284; 7, p. 345; 8, p. 388.

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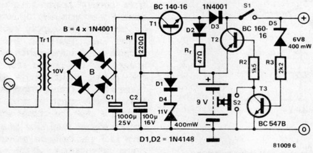
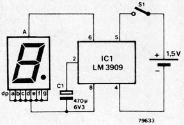


Figure 6. A recycling circuit for an output of 9 V at up to 500 mA is shown here.

flashing badge

Although primarily intended as a conversation piece at parties etc. the circuit described here can be used in numerous applications ranging from flashing house numbers to seat belt reminders. The circuit itself could hardly be simpler as it uses just one LM 3909 IC and a capacitor. When used as a flashing badge, the circuit is designed for use with a single HP7 (or similar) battery which can be mounted inside one half of a battery holder while the capacitor and IC are mounted in the other half. There



are a number of possibilities for the badge display itself. The author suggests the use of a line-o-light LED display or a seven-segment display (encapsulated in a suitable resin) to show the initial of the flasher!
Prospective constructors should bear in mind that the maximum output capability of the LM 3909 is around 50 mA. ◀

L. Goodfriend
(United Kingdom)

DIGITAL DIAL/INSULATION TESTER

Sbaj Electronics have developed a digital dial/insulation tester with seven segment LED display. It can measure insulation resistance of cable in 4 M Ohms and 10 M Ohms ranges. It can also be used for measurement of telephone dial speed, impulse count and weight break ratio.

For further information, write to:

Sbaj Electronics,
19, Mother Gift Building,
Opp. Novelty Cinema,
Grant Road,
Bombay 400 007.

RF CONVERTER

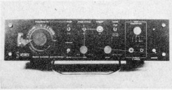
Altos India have introduced a new RF Converter, Model 3001, for converting video and audio signals of any video equipment into a modulated RF signal. The converter is used for interfacing equipment like UHF VCR/VCP, Video camera, Video Games, Personal Computers etc. with a VHF colour or black and white TV receiver.

For further information, write to:

Altos India Ltd.
A-79, DDA Sheds,
Okhla Industrial Area, Phase II,
New Delhi 110 020.

SWEEP/FUNCTION GENERATOR

The new sweep/function generator from Series Audio Systems has a frequency range of 0.1 Hz to 1 MHz. Sine, Square, Triangle and TTL Pulse outputs are available with high current capability into 50 ohms. The sweep range is 1:1000 Log or Linear. The generator is compatible with oscilloscopes and XY recorders.

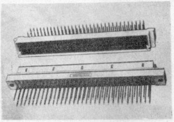


For further information, write to:

Series Audio Systems Pvt. Ltd.
149 B, D.D.A. Sheds,
Okhla Industrial Area, Phase II,
New Delhi 110 020.

EURO CONNECTORS

O/E/N Connectors Ltd. have introduced a high density Euro card connector with 96 contacts in three rows. Other Euro connectors are also available with 32,48 or 64 contacts, with 5.08/2.54 mm spacing. All standard terminations like wire wrap, solder pins and solder eyelets can be supplied.

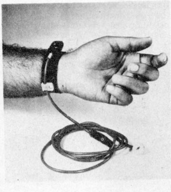


For further information, write to:

O/E/N Connectors Ltd.
Vyttila,
Cochin 682 019.

STATIC CONTROL WRIST STRAP

Marvel Products have introduced a wrist strap with ground cord which can instantly dissipate static charge on the person wearing it. The strap is 25 cm long, adjustable to any wrist size. The ground cord is a soft insulated wire with 1 M ohm resistance in series. Aligator clip is provided at the end of cord. The device is claimed to be effective protection against potential damage to static sensitive components.



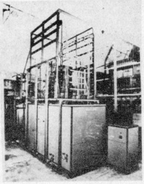
For further information, write to:

Marvel Products
208 Allied Industrial Estate,
M.M. Chhotani Road,
Mahim, Bombay 400 016.

ULTRASONIC CLEANING SYSTEM

Vibronics Pvt. Ltd. have specially designed a multistage ultrasonic cleaning system for textile machinery manufacturers. The system is designed to carry the parts automatically through the cleaning stages.

A typical application is cleaning of fluted/knurled rollers used in manufacture of textile machinery.



For further information, write to:

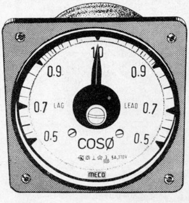
Vibronics Pvt. Ltd.
Masrani Estate, Near Halav Pool,
Kurla,
Bombay 400 070.

PANEL METER

MECO have introduced a new panel meter in the 110 x 110 mm square format. It has a 240° circular scale with a clear acrylic square front, and the moulded body is of 100 mm diameter.

Ammeters, Voltmeters, Frequency meters, Watt meters, P.F. meters and VAR meters are available in this new format.

These meters have been developed primarily for deffence use, and hence claimed to be very robust in construction.



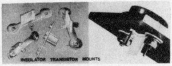
For further information, write to:

MECO Instruments Pvt. Ltd.
Bharat Industrial Estate
T.J. Road, Sewree
Bombay-400 015.

market

INSULATOR MOUNTS

The insulator mounts for power transistors from SEE are of one piece design. This simplifies mounting of power transistors and improves thermal efficiency. The mounts are provided with built in barrier to eliminate the need of sleeving of base and emitter connections. The material used for these mounts is claimed to be resistant to most common solvents, alkalies, dilute acids, petroleum oils and greases.



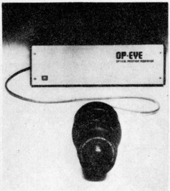
For further information, write to:

Suresh Electrics & Electronics
Post Box No. 9141
3B, Camac Street,
Calcutta 700 016.

OPTICAL POSITION SENSING SYSTEM

United Detector Technology of California U.S.A. have announced a new optical position sensing system, Op-Eye 5. The system features 16 analog input lines for optical position sensing and 16 digital I/O lines which provide feedback capability and auxiliary data input. Two analog outputs are available for operating alarms and controls.

Applications include mirror alignment, measurement of surface curvature or straightness of lathe beds, precision centering and nulling operations, bio engineering studies and various automated assembly operations.



For further information, write to:

Toshni-Tek International,
267 Kilpauk Garden Road,
Madras 600 010.

PORTABLE CALIBRATOR

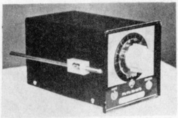
A portable calibrator suitable for industries as well as laboratories has been developed by Classic Electronics. It can source DC Voltages from 10 μV to 100 V with load currents upto 100 mA, DC currents from 10 nA to 100 mA with load voltages upto 100 V.A., monitor switch is provided to facilitate measurement of load during calibration. It can measure DC voltages upto 200 V and DC currents upto 100 mA, in five ranges. Resistance measurement is also possible.

For further information, write to:

Varahi Enterprises,
Anatalaya Buildings,
N.S. Road,
Mysore-570 001
Karnataka

TEMPERATURE CONTROLLER

Industrial Techs have developed a solid state electronic blind temperature controller for 0°C to 1600°C range. The model TC-601 is a non-indicating controller with plug-in construction. Applications include control of power supply to furnaces, ovens and heat treatment plants.

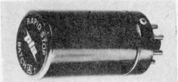


For further information, write to:

Industrial Techs
Hanumant Gaydhane Chawl,
Opo. Market Yard,
Newasa Road,
Shrirampur-413 709.

RAPID STOP UNIT

PLA Rapid stop unit housed in miniature plug-in assembly suitable for mounting on octal socket is an electronic unit which employs amplifier circuit with output stage to drive external relay. Intrinsically safe, PLA Rapid stop unit is used in Stop Motions associated with textile machineries such as draw frame, speed frames, carding machine combers etc.



For further information, write to:

SAI Electronics
Thakor Estate,
Kurla Kirol Road,
Vidyavihar (West)
Bombay 400 086.

PERSONAL COMPUTER

MPF-II is a personal computer which can find application in education, business, home management and entertainment. It can be interfaced with a colour TV or video display unit, many pre-written programmes are available for accounting, payroll, job costing and inventory control. It is also compatible with Apple II software. The MPF-II personal computer is based on R6502 CPU. It has 16K Bytes ROM and 64K Bytes RAM. Screen format is 24 lines × 40 columns of 5 × 7 dot matrix characters. Graphics capacity is 1920 blocks or 53760 dots.

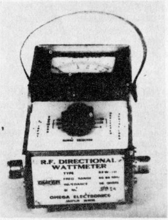
For further information, write to:

Brisk Sales Corporation
394-A, Lamington Road
Lamington Chambers, 2nd floor
Bombay 400 004.

RF WATTMETER

The R.F. Directional Wattmeter type RFW-145 from Omega Electronics is a protable unit, designed to measure forward and reflected power in 50 ohms coaxial transmission lines. The insertion VSWR is claimed to be less than 1.05.

The meter has a frequency range of 68 68 MHz to 88 MHz and reads directly in Watts in three ranges - 5 W, 25W and 50W. It is supplied in an aluminium housing with a carrying strap of leather. The unit is self contained and needs no external power sources for operation. The RFW—145 can be used for continuous monitoring of transmitter output or for checking antenna or line faults.



For further information, write to:

Omega Electronics
36-Hathi Babu Ka Bagh
Jaipur 302 006.

SINE WAVE INVERTERS

Advance Industries manufacture a wide range of inverters. These Inverters can be used as back up supply or source of AC supply from available DC supply in industries, hospitals, warning systems and for operating TVs, stereos, video equipment etc. from car batteries.

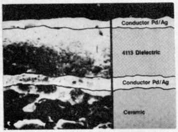
Advance inverters are claimed to have quick start operation, frequency stability and a regulation of ±2% or better. The unit is protected against output overload and against input polarity reversal.

For further information, write to:

Advance Industries
11, Tinwala Building
Tribhuvan Road, Near Dreamland Cinema
Bombay 400 004.

CAPACITOR DIELECTRICS

New thick film capacitor dielectrics—4113, 4114 and 4115 claim excellent electrical performance even under very humid conditions. These are manufactured by Electro-Science Laboratories Inc. U.S.A. and are marketed in India by Eltecks. These are high density dielectrics which do not need a glassy binder. They can achieve K values upto 100. The materials are fired at 850°C to 1000°C and have good adhesion to alumina. Main areas of application are capacitor arrays, delay lines, RC networks etc.



For further information, write to:

Eltecks Corporation
C-314, Industrial Estate
Peenya
Bangalore 560 058.

TWILIGHT SWITCH

National Electronics have developed a twilight switch for automatic switching ON and OFF at dusk and dawn. It is mainly used for switching lights in streets, airports, hospitals, offices, factories, railway yards, hoarding lights, neon signs etc. The twilight switch is claimed to have trouble free operation in temperature as high as 85°C. It is also shock and vibration resistant and can withstand continuous exposure to sun and rain.

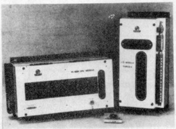
For further information, write to:

National Electronics
105, Princess Street
Damodar Building, IInd floor
Bombay 400 002.

PROGRAMMABLE LOGIC CONTROLLER

ADOR PC—4896 is a programmable logic controller from Advani—Oerlikon which can accept a maximum of 96 Input/Outputs. It is useful for continuous process plants where sequencing, firing, interlocking and precise speed control applications are involved.

The design is based on a single microcomputer chip and uses solid state circuitry. The unit is simple to programme and operate, modular in construction and compact in size. Power consumption is low.



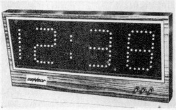
For further information, write to:

Advani—Oerlikon Ltd.
Post Box 1546
Bombay 400 001.

ELECTRONIC DIGITAL CLOCKS

SENSOR electronic digital clocks have 3.5 inch high numerals of bright red or green LEDs for good visibility from a distance. These clocks can operate on 230V AC or in case of power failure, back up power supply is provided in form of 6 torch batteries of 1.5V each. Exact time is displayed as soon as AC power is restored.

Accuracy of ±15 seconds per month is claimed because of Quartz crystal oscillator and use of CMOS ICs used in the circuit. The clocks are supplied in teakwood, rosewood or sunmica cabinets.

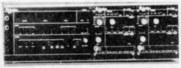


For further information write to:

Product Promoters.
Post Box 3577
F-41 Lajpat Nagar II
New Delhi 110 024.

WAVEFORM RECORDERS

Anika claim a breakthrough in the data acquisition technology and announce their series 4000 multichannel waveform recorders. These recorders can be configured from 1 to 4096 channels. Sampling rates from 100 KHz to 10 MHz and a choice of memory capacity from 2K to 32K is available. Built in computer interfaces like RS 232C and IEEE-488 are also provided. Digital as well as analog input/output facility is available. The design is modular in nature and the number of channels can be increased just by adding more modules without affecting the performance of individual modules.

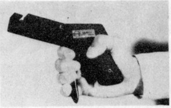


For further information, write to:

Anika Instruments (P) Ltd.
24-Housing Society, N.D.S.E. (I)
New Delhi 110 049.

WIRE TERMINATOR

The AM-60114 self-indexing hand gun for insertion of discrete wires into insulation displacement connectors is introduced by Molex. The gun features snap-on modular dies for termination of wires on 2.5 mm, 5 mm as well as 0.1 inch and 0.2 inch centerline Molex connectors. A module is also available for use with 0.05 inch ribbon cable.



For further information, write to:

Jay Electric Wire Corporation Ltd.
202 Maker Tower E, 20th floor
Cuffe Parade
Bombay 400 005.

SINE—SQUARE OSCILLATOR

Rashmi Electronics introduce their Sine-Square Oscillator type F-16 with frequancy range of 10 Hz to 1 MHz, in five decades-continuously variable. Out put impedance is 600 ohms nominal and the amplitude is continuously variable from 0 to 10 V. Output amplitude remains constant over the entire range.

For further information, write to:

Rashmi Electronics
2-15-34, Kadrabad, (Polas Lane Corner)
Jalna 431 203.

classified ads

CONDITIONS OF ACCEPTANCE OF CLASSIFIED ADVERTISEMENTS

1) Advertisements are accepted subject to the conditions appearing on our current rate card and on the express understanding that the Advertiser warrants that the advertisement does not contravene any trade act inforce in the country.

2) The Publishers reserve the right to refuse or withdraw any advertisement.

3) Although every care is taken, the Publishers shall not be liable for clerical or printer's errors or their consequences.

4) The Advertiser's full name and address must accompany each advertisement submitted.

The prepaid rate for classified advertisement is Rs. 2.00 per word (minimum 24 words). Semi Display panels of 3 cms by 1 column. Rs. 150.00 per panel. All cheques, money orders, etc. to be made payable to Elektor Electronics Pvt. Ltd. Advertisements, together with remittance, should be sent to The Classified Advertisement Manager. For outstation cheques please add Rs. 2.50

Electronics Tools like Soldering Irons, Pliers,, Cutters, Screw Drivers, Tweezers at Competitive Prices. Contact Aradhna Electronics (P) Ltd., 10, Srinath Complex, Sarojinidevi Road, Secunderabad 500 003.

advertisers index

missing link

musical doorbell

(August/September 1984, page 8-80)

Please note that the ICs type UM3581/2/3/4 are available from
Midas Telecom
1 Oaklands Grove
London W12 OJD
Phone: (01 743) 3882

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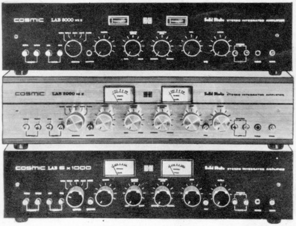

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& Printed at Trupti Offset, 103, Vasan Udyog Bhavan, Off Tulsi Pipe Road, Lower Parel, Bombay-400 013.